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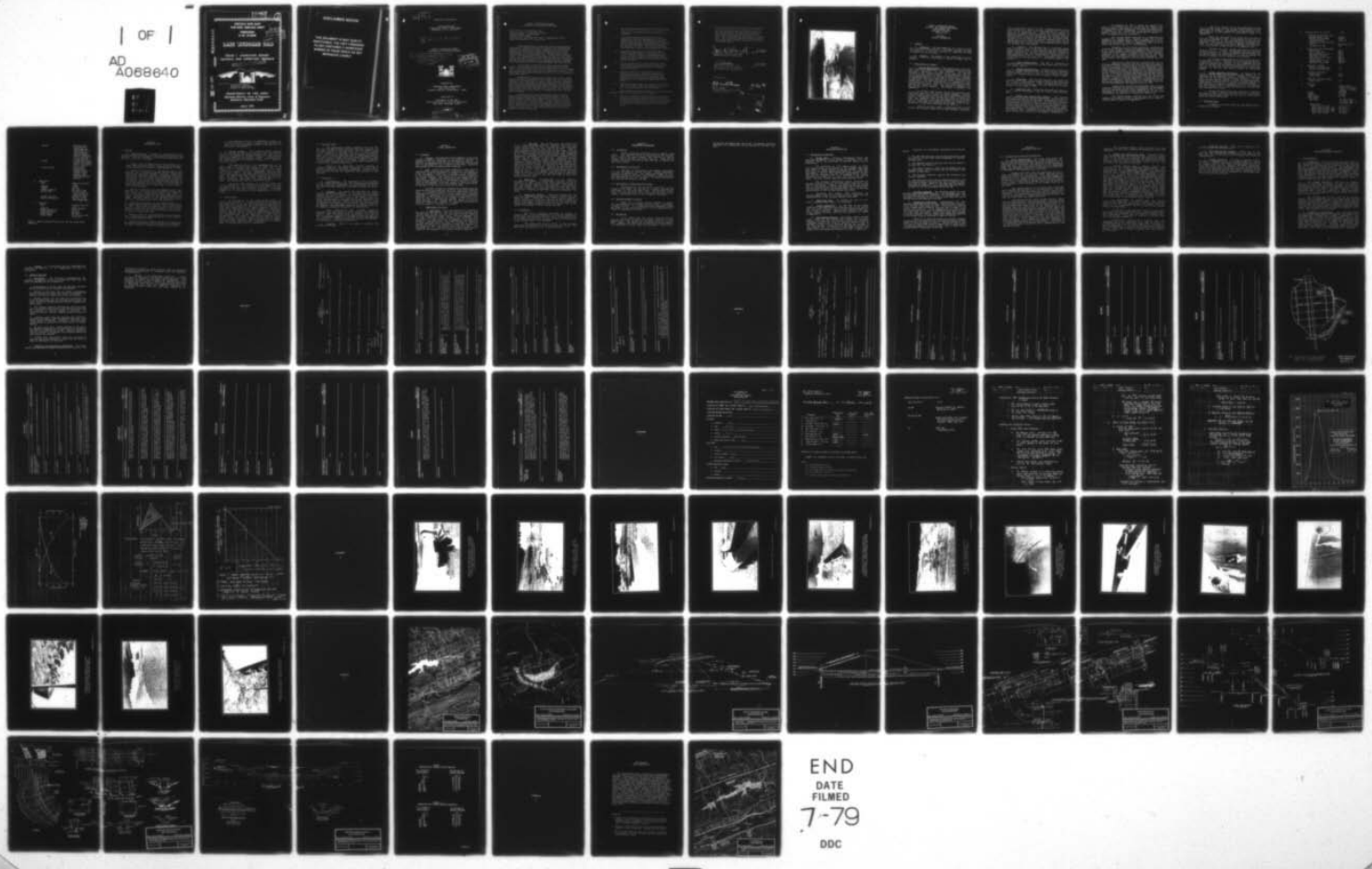

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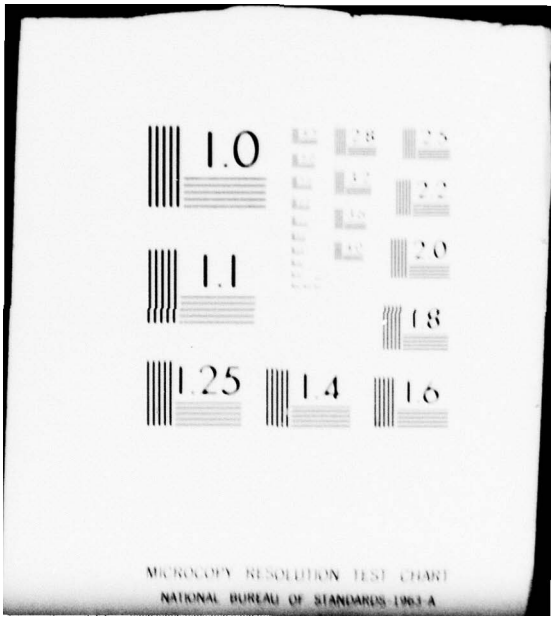
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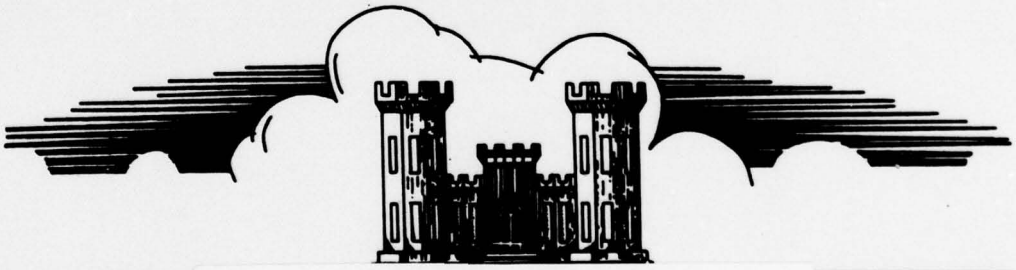
SCHUYLKILL RIVER BASIN
PLUM CREEK, SCHUYLKILL COUNTY
PENNSYLVANIA
ID NO. PA.00702

LAKE WYNONAH DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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DEPARTMENT OF THE ARMY
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JULY 1978

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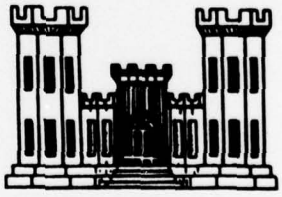
SCHUYLKILL RIVER BASIN

LAKE WYNONAH DAM
SCHUYLKILL COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00702

(15) DACW31-78-C-0048

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(6) National Dam Inspection Program. Lake Wynonah Dam (PA00702), Schuylkill River Basin, Plum Creek, Schuylkill County, Pennsylvania. Phase 1 Inspection Report.



Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name Of Dam: Lake Wynonah Dam
County Located: Schuylkill County
State Located: Pennsylvania
Stream: Plum Creek
Coordinates: Latitude 40° 35.8' Longitude 76° 09.4'
Date of Inspection: 11 July 1978

Lake Wynonah Dam is owned by the Lake Wynonah Property Owner's Association and is located in South Mannheim Township in Schuylkill County, Pennsylvania. The dam was designed by the original owner, American Realty Service Corporation, of Memphis Tennessee, together with Gannett Fleming Corddry and Carpenter, Inc., of Harrisburg, Pennsylvania. The embankment was completed on July 13, 1971, and has been in service ever since. The facility is in good condition with the exception of the seepage emanating through the downstream sections of the embankment and along the toe.

Calculations indicated that the existing spillway systems are designed to pass the probable maximum flood (PMF). Therefore, the spillway is considered to be "Adequate". It is noted that when flows exceed twenty-five percent of the PMF significant property damage is likely to occur downstream along Plum Creek.

Cracking and rotation of the spillway channel walls were noted and is considered undesirable, but it is not considered to be indicative of a potentially unstable condition. A review of the structural analysis indicates that the ACI code was used which does not provide sufficient steel to prevent temperature and shrinkage cracks in hydraulic structures. It was also noted that the spillway retaining wall footings are slightly too narrow which is probably the cause for the wall rotations.

Considering the zoned embankment design with the downstream pervious section and drainage blanket, the observed seepage through the embankment and toe is to be expected but it is also undesirable. It is noted that there were no indications such as slope bulging, slope sliding or other conditions to indicate a potentially unstable embankment. Considering the items summarized herein and described in detail in Section 7, the following measures are recommended in order of priority.

1. The seepage discharging around the pond drain outlet works and adjacent areas should be monitored for increases in flow or changes in turbidity.

2. Considering the quantity and locations of seepage through the embankment, it is recommended that a series of piezometers be installed perpendicular to the dam axis through the maximum embankment section to delineate the phreatic profile. The profile should be evaluated by a registered professional engineer.

3. Rotations noted along the spillway chute retaining walls should be periodically monitored. Should excessive deflections be observed as determined by a registered professional engineer, appropriate remedial measures should be taken.

4. Cracks along the weir chute walls and chute slab should be monitored; and if seepage is observed through these joints, the joints should be sealed.

5. The boat marina, located upstream of the emergency spillway, should be assessed and appropriate measures taken to minimize the possibility of the docks or boats floating downstream and clogging the spillways during storms.

6. Downstream flows should be monitored to verify that the minimum flow requirements noted in the application permit are satisfied.

Recommendations concerning the operation and maintenance of the dam are presented as follows:

1. The owner should develop an operation and maintenance procedure together with an inspection checklist to insure that all items are inspected, operated and maintained on a regular basis and in accordance with the designer's recommendations.

2. A formal procedure of observation and warning during periods of high precipitation should also be developed and implemented because of the possibility of extreme property damage downstream during periods of high flow. In the event of dam failure, loss of life is probable. This procedure should include methods of warning and, possibly, evacuating residents along Plum Creek.

John H. Frederick, Jr., P.E. Date 8/26/78
Maryland Registration 3701
Woodward-Clyde Consultants

William S. Gardner, P.E. Date 8/26/78
Penna Registration 004302E
Woodward-Clyde Consultants

APPROVED BY:

G. K. WITHERS Date 10 Sep 78
Colonel, Corps of Engineers
District Engineer

OVERVIEW
LAKE WYNONAH DAM, SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LAKE WYNONAH DAM
NATIONAL ID #00702
DER #54-176

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Wynonah Dam is a 92 foot high, zoned earth embankment. The dam measures 950 feet along the crest impounding a 175 acre reservoir. The dam was designed to use locally available borrow materials and contains two primary material zones. The upstream zone, consisting of approximately 2/3 of the dam cross-section, is composed of impervious materials classified as clayey sands and silty clayey sands. The downstream section, which consists of approximately 1/3 of the cross-section, is composed of a pervious coarse-fill zone. There is a 2-foot thick blanket drain beneath the coarse-fill zone. The toe drain discharges into the natural stream channel. See Plates 2 through 7 of Appendix E.

A 24-foot wide cut-off trench was excavated into sound rock along the centerline to control seepage. A double line split-spaced grout curtain was constructed below the core trench. The maximum hole spacing was 5 feet on center and holes were staggered 5 feet up- and downstream of the centerline. The upstream slope contains benches at elevations 634 and 588. The slope is riprapped from the upper bench to elevation 646 (3 feet below the crest of the dam).

Most of the year, water is discharged from the dam through the spillway located on the right abutment, maintain-

ing a normal pool elevation of 640. Discharge passes over a concrete ogee weir, down a chute spillway and into a stilling basin at the downstream toe. During the winter months, or when work is required along the shore line, the pond drain is opened by means of a valve located near the crest of the dam. The pond drain, located at the upstream toe, discharges water through a 36-inch reinforced concrete pressure pipe into an impact basin at the down stream toe. The pond drain system was designed with a 2-inch pipe and discharge outlet to maintain minimum flow requirements.

b. Location. Lake Wynonah Dam is constructed across Plum Creek at a point 8,500 feet east of the Wayne-South Manheim Township line in South Manheim Township, Schuylkill County, Pennsylvania. The dam site and reservoir are shown on USGS Quadrangle entitled, "Friedensburg, Pennsylvania," at coordinates N 40° 35.8', W 76° 9.4'. A regional location plan of Lake Wynonah Dam and reservoir is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as "Intermediate" by virtue of its 92-foot height and 5,737 acre-feet normal capacity.

d. Hazard Classification. A "High" hazard classification is assigned consistant with the potential for extensive property damage and loss of life 1.5 miles downstream along Plum Creek (between points A and B as shown on Plate 1, Appendix E).

e. Ownership. The dam and reservoir are owned and operated by the Lake Wynonah Property Owner's Association, RD No. 1, Auburn, Pennsylvania 17922. The property was transferred from the original owner, American Realty Service Corporation, in the summer of 1975.

f. Purpose of Dam. The dam was designed and constructed to create a recreational lake for a real estate development.

g. Design and Construction History. The original owner, American Realty Service Corporation, prepared most of the design calculations and drawings, construction specifications and also constructed the dam. The hydrologic analysis was performed by Gannett Fleming Corddry and Carpenter, Inc. of Harrisburg, Pennsylvania. The soils and subsurface investigations together with construction, quality control inspection and testing was performed by G. K. Jewell and Associates of Columbus, Ohio. Foundation grouting was performed by the Royal Contracting Corporation of Bridgeport, Pennsylvania.

On September 28, 1970, a permit was issued by the state to allow construction of the dam and the "Report upon the Application," was prepared by the State of Pennsylvania, on November 25, 1970. Proceedings of the Delaware Basin Commission, Docket No. D-71-11 were submitted on February 1, 1971, and approved shortly thereafter.

The original design consisted of a homogeneous embankment with a chimney drain. However, by May, 1971, a zoned embankment was adopted based on the recommendations of G. K. Jewell and Associates. Plate 3, Appendix E, shows the final design and as-built section of the embankment.

Subsequent to core trench excavation, grouting was performed by the Royal Contracting Company under the direction of Mr. Albert Depman, consulting geologist. The entire core trench was grouted with the exception of the south abutment. According to Mr. Depman, geologic conditions at the south abutment were favorable and grouting was unnecessary. DER files contain what appears to be all grout records for this work.

Construction specifications required that the impervious embankment materials and the core trench be placed at a moisture content 2 percent above the optimum moisture content as determined by the Standard Proctor Compaction Test, AASHO T-99 or ASTM D 698, and a density of at least 98 percent of the maximum dry density as defined by the Standard Proctor Curves. Construction records submitted by the resident engineer for G. K. Jewell and Associates indicated that the average dry density of this material was greater than the required 98 percent. Inspection records submitted by inspectors for the State of Pennsylvania (State Inspectors) indicated that earthworks were placed at a maximum rate of 17,000 cubic yards per day and the embankment was completed July 13, 1971.

Construction records and photographs taken by State Inspectors indicate the spillway was excavated into decomposed rock and spillway excavation was completed by July 1, 1971. According to an inspection report dated March 18, 1971, and photographs, the pond drain is located on intact rock.

The specifications required that the filter bed beneath the riprap be graded in accordance with the specifications shown on Plate 9 of Appendix E.

The filter blanket was to be constructed of materials defined in Section 703, Standard Specifications of the Department of Highways, Commonwealth of Pennsylvania, 1970. The gradation of this material is presented on Plate 9 of Appendix E.

Water was impounded during construction and was 40 feet deep by November 5, 1971. By the Spring of 1972, all essential features of the dam and appurtenant structures were completed. The dam was officially completed on December 15, 1972. It was reported by the owner's manager that the reservoir filled during a single storm in the summer of 1972.

On March 29, 1974, leakage was noted by the State Inspector, Mr. J. J. Ellam. He assessed that the condition was not hazardous. Mr. Ellam recommended that additional rock be placed beyond the downstream toe to control leakage and direct the leakage into the natural stream channel.

An inspection performed by the State of Pennsylvania on September 7, 1977, indicated that the structure was performing satisfactorily. However, it was recommended that the trees be removed from the downstream slope and that the left wall of the emergency spillway be monitored for additional movement, as the wall had rotated outward an undisclosed amount.

h. Normal Operating Procedures. As required by the Permit, a minimum flow of 0.46 cubic feet per second (cfs) is required into the downstream channel. However, if flows less than 0.46 cfs are measured entering the reservoir, the downstream release may be reduced to equal the measured inflow. There was no evidence found of any weirs located upstream or downstream of the reservoir to monitor inflow and outflow. It was reported by the Owner's representative, Mr. Jerry Miller, that the minimum flow is always maintained by a 2-inch pipe near the pond drain intake.

During the winter months the reservoir is lowered 3 to 5 feet or more to protect the docks and other facilities located along the water's edge from ice forces. There are no operating records maintained.

1.3 Pertinent Data.

A summary of pertinent data for Lake Wynonah Dam is presented as follows:

a.	Drainage Area (sq. miles)	3.04
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood	Unknown
	Maximum Design Flood	(Note 1)
	Freeboard Flood	(Note 1)
	Maximum Flow Through Pond Drain	No rating curve
	Discharge at PMF	4133
c.	Elevations (feet above MSL)	
	Top of Dam	649.0
	Top of Spillway	640.0
	Spillway Exit Invert	543.0
	Pond Drain Invert	561.3
	Pond Drain Exit Invert	544.4
	Normal Pool	640.0
	Maximum Known Flood	Unknown
	Maximum Pool at PMF	649.0
d.	Reservoir (miles)	
	Length at Normal Pool	1.7
	Fetch at Normal Pool	1.0
e.	Storage (acre-feet)	
	Normal Pool	5737
	Top of Dam	7476
f.	Reservoir Surface (acres)	
	Normal Pool	175
g.	Dam Data	
	Type	Zoned rolled earth with downstream drainage blanket
	Length	950 feet
	Height	92 feet
	Crest Width	24 feet
	Side Slopes	
	Upstream	3:1 (H:V) with 10 feet berm at elevation 588
	Downstream	
	Crest to Elev. 610	2.5:1 (H:V)
	Berm Width at Elev. 610	10 feet
	Elev. 610 to Elev. 580	2.5:1 (H:V)
	Berm Width at Elev. 580	10 feet
	Elev. 580 to Toe	3:1 (H:V)

Zoning	Upstream Impervious Zone I; Downstream pervious Zone II; 2 feet drainage blanket beneath Zone II extending 1/3 of section to edge of Zone I.
Cutoff	24 feet wide (base width) core trench with 1:1 slopes to top of rock.
Grout Curtain	2-line split spared holes through cutoff trench; 5-foot spacing staggered across centerline.

h. Pond Drain

Type	Concrete pressure pipe
Diameter	3 feet
Length	620 feet
Intake Location	U/S toe of dam
Sluice Gate	36" with valve stem running upslope to crest.
Outlet Location	D/S toe of dam
Outlet Description	Concrete outlet with Impact Wall

i. Spillway

Type	Concrete Ogee Section
Location	Right abutment
Width (effective)	38 feet
Discharge Chute	Concrete
Chute Length	442 feet
Chute Slope	Varies from 0.026 to 0.320

Note 1: Design calculations are not for the constructed spillway.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data on Lake Wynonah Dam is presented on the checklist attached as Appendix A. Principal documents containing pertinent data used for this report are as follows.

1. "Report upon the Application of Lake Wynonah, Inc., and/or American Realty Service Corporation," by Joseph J. Ellam, DER Hydraulic Engineer, dated November 25, 1970.

2. "Design Calculations for Lake Wynonah Dam at Lake Wynonah, Inc.," by American Realty Service Corporation, engineering department, Memphis, Tennessee, dated 1970. This report contained hydraulic calculations, stability calculations and structural calculations for the spillway system. It is noted that these calculations were for a different configuration of spillway than presented on the design drawings and constructed. It is not known if other stability calculations were made to assess the as-constructed spillway.

3. "Design calculations for Lake Wynonah Dam at Lake Wynonah, Inc.," by Gannett Fleming Corddry and Carpenter, Inc., Harrisburg, Pennsylvania, dated July, 1970, job #5377. This report contained hydrologic computations including inflow hydrograph for the maximum probable flood (PMF). Spillway capacity curves and reservoir routings were for a spillway system other than that built.

4. "Subsurface Investigation, Lake Wynonah Dam," by G. K. Jewell and Associates, Columbus, Ohio, dated October 27, 1970. This report included an analysis of the local geology; results of field investigations; results of laboratory testing; borrow source conditions; and specifications for curtain grouting.

5. "Specifications for Lake Wynonah Dam at Lake Wynonah, Inc.," prepared by the American Realty Service Corporation, dated September, 1970.

6. "Construction plans stamped 'As-Built'," prepared by the American Realty Service Corporation, dated September 25, 1970. This work included a 15-sheet set of plans.

7. Miscellaneous letters, correspondence, memos, including construction progress reports and 64 black and white and color photographs located in the DER files in Harrisburg, Pennsylvania.

b. Design Features. The principal design features are illustrated on the plan, profiles and cross-section plates of the embankment and appurtenent structures that are enclosed in Appendix E as Plates 2 through 7. These plates were reproduced from the "As-Built Plans". A description of the design features is discussed in Section 1.2, "Description of Project."

The upstream side of the embankment has a 3:1 (H:V) slope; two 10-foot wide berms at elevations 634 and 588.0; and is riprapped from elevation 634.0. The riprap consists of a 1.5-foot thick riprap layer over a 1-foot thick filter blanket. The top of embankment, elevation 649, is a private road, 24 feet wide, with guard rails along each side. The downstream slope contains two berms at elevations 610.0 and 580.0. The slope above elevation 580 is 2.5:1 (H:V). Below the lower berm, the slope increases to 3:1 (H:V). The downstream slope is covered with grass.

The pond drain consists of a 36-inch sluice gate at the upstream toe, 36-inch RCP pipe and an impact basin at the downstream toe. The spillway is located in the right abutment of the dam with a 40-foot wide weir. A roadway bridge pier is located about 6 feet downstream of the weir crest.

2.2 Construction.

A description of the construction history is presented in Section 1.2. Construction was performed under the supervision of Mr. Rod Smith representing the American Realty Service Corporation, and construction inspection reports were signed by Mr. G. K. Jewell, Engineer. Foundation grouting was supervised by Mr. Albert Depman, Consulting Geologist for the Royal Contracting Corporation. Available records indicate that Mr. Joseph J. Ellam, Hydraulic Engineer, performed most of the inspections for the State of Pennsylvania. Mr. Jewell's construction progress reports and Mr. Ellam's inspection reports indicate that the foundation was properly prepared, properly grouted and the embankment and filter materials were constructed in accordance with or exceeding specification requirements.

2.3 Operation Data.

The Construction Permit, together with the "Report Upon the Application" indicates that the discharge system shall maintain a minimum flow of 0.46 cfs unless inflow to the reservoir is less than 0.46 cfs. If the reservoir flow is measured the discharge may be reduced accordingly. There are no records that this flow is being maintained nor are there weirs or other measuring systems upstream or downstream to measure inflows or outflows. However, construction drawings indicate an inlet system which automatically releases the required minimum flow.

There are no operational records available to document discharge, high water elevations or other operational procedures and discharge downstream. The pond drain was exercised during the inspection and observed to work properly.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and studied for this inspection were provided by the Pennsylvania Department of Environmental Resources. The Owner provided additional information during the inspection.

b. Adequacy. The design data provided was comprehensive and well documented. It is noted that the design drawings and as-built spillway are different from the design sections used for analysis. It is not known if the discharge characteristics are identical but an approximate analysis was performed to evaluate the overall capacity of the as-constructed spillway. These calculations are presented in Appendix C and described in Section 5. Construction data was adequate and photographs taken by the DER were especially helpful in assessing the quality of construction.

Other construction data included inspection memoranda and construction progress reports and inspection reports. With the exception of the hydraulic data and the lack of stability analysis in the design data, all other data is considered adequate to evaluate the dam and appurtenant structures. A more thorough description of the stability evaluation is presented in Section 6.

c. Validity. There is no reason to question the validity of the data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed as Appendix B and are summarized and evaluated as follows. In general, the appearance of the facility indicates that the dam and its appurtenances were properly constructed, reasonably maintained, and in reasonably good condition.

b. Dam. During the visual inspection, there were no indications or evidence observed of distortion in alignment or grade that would be indicative of movement of the embankment or the foundation. There were no surface cracks, sloughing, or erosion observed. The riprap was in very good condition and stable. Seepage was noted during the inspections performed between 1974 and 1977. Photographs were taken in 1977. Since no measurements were taken, rates of change of seepage could not be assessed. Since the seepage is not concentrated, an estimate of the flow rate could not be made.

As shown on Sheet 5a, Appendix B, standing water was observed below the downstream toe on the right side of embankment. It is assumed, based on previous inspections, that this standing water has existed for several years and has remained unchanged. Considering the pervious downstream embankment materials and the blanket drain, seepage is expected to occur along the base of the dam and, perhaps, up the slope for a small distance. This seepage does not appear to indicate hazardous conditions, although it should be monitored for rates of change or increases in turbidity.

c. Appurtenant Strucures.

1. Pond Drain. Since the pond drain is located at the base of the reservoir and the concrete discharge pipe located below the dam, the only items that could be inspected were the valve and the impact basin. The valve appeared to be in good condition, clean, painted and reasonably well lubricated. It was exercised and appeared to be operating properly. The impact basin was inspected and observed to be in good condition with no signs of cracking or spalling. Seepage was noted to be discharging around the wing walls of the basin and water was flowing over the left wall. See Photograph No. 13. Considering the drainage system incorporated in the embankment this seepage would be expected.

2. Spillway. The spillway weir was observed to be in relatively good condition. However, there were some cracks noted along the left retaining wall and horizontal cracks located along the left side of the weir. Signs of past seepage were noted through many of the cracks. The approach channel retaining walls have rotated. See Photograph No. 8. This movement was observed during a State inspection performed in September, 1977; and the State inspector recommended that the movement be monitored. Along the spillway chute several diagonal cracks and occasional vertical cracks, generally located between construction joints, were observed. Occasional wall rotations were also observed between construction joints. At the base of both chute spillway walls fillet concrete was noted to be deteriorated and broken at several locations. Sections of the fillet concrete up to 2 or 3 feet long were dislocated and scattered along the chute. It is apparent that this fillet was never bonded to the chute slab or the retaining wall or separation cracks were also noted at the base and sides of the fillet along the entire chute.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability or other features that would significantly affect the flood storage capacity of the reservoir. All slopes above the reservoir were well vegetated with grass and trees. The upper reaches of the drainage basin are also well vegetated with residential dwellings scattered throughout the basin.

e. Downstream Channel. Immediately downstream the pond drain and emergency spillway channels converge and pass under LR 53007. Thereafter, the channel passes through a narrow flood plain containing several private bridges and farms. The channel is stable with a gravel and rock bottom. Significant property damage and possible loss of life is expected in the event of failure during the PMF.

3.2 Evaluation.

The visual inspection disclosed no evidence of apparent past or present movements to indicate instability of the dam. The wet areas noted on Sheet 5a, Appendix B are to be expected considering the type of materials and drainge system incorporated in the embankment.

The cracks and rotation noted on the spillway walls were interpreted to be the result of the design. The pond drain was assessed to be in good condition.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal operating procedures do not require a dam tender. The reservoir level is maintained by the spillway weir. During the winter months, the reservoir is lowered several feet to protect the docks from ice. There are no written procedures designating when and how to operate the pond drain system.

4.2 Maintenance of the Dam.

The dam is maintained by the Owner's representative who periodically checks the dam. Normal maintenance consists of mowing grass. The downstream seepage is occasionally checked by the Owner for changes in flow rates but the observations are not recorded. No major maintenance work has been performed to the dam.

4.3 Maintenance of Operating Facilities.

Maintenance of the operating facilities is performed by the Owner and consists of a regular cleaning and lubrication of the pond drain valve. On occasion, divers check the trash racks for debris and clean the racks as necessary. Maintenance work is not recorded by the Owner.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. It is understood that responsible people are always in the area and available to warn downstream residents of impending high flows.

4.5 Evaluation.

It is judged that the current operating procedures are sufficient to operate the simple facilities of Lake Wynonah Dam. The maintenance procedures used are sufficient. However, the Owners are not monitoring wall movements as recommended by State Inspection personnel. Since a for-

mal warning procedure does not exist, a procedure should be developed and implemented during periods of extreme rainfall.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. Original hydrological design was performed by Gannett Fleming Corddry & Carpenter, Inc. The hydraulic design was performed by American Realty Service Corporation.

The watershed is 3.04 square miles, of which 0.98 square miles is controlled by the upstream Fawn Lake Dam, which is judged capable of passing the PMF. Both dams were built to provide recreational lakes for a vacation home development. Of the total watershed, approximately 35 percent is now developed and it is expected to be totally developed with homes on 1/3 acre lots within the next 10 years. The area is well vegetated with grass and trees.

The original hydrological design calculated the probable maximum flood for the watershed, using the 6 hour and 12 hour storms. However, the upstream dam was ignored both in determining the inflow hydrograph and in flood routing the storm through Lake Wynonah Dam. Also, the spillway system design is not the same system constructed.

Consistent with Federal (OCE) Guidelines, the spillway design flood for this dam with this hazard and size classification is the probable maximum flood (PMF).

b. Experience Data. No records are kept of rainfalls, reservoir water levels, or discharges.

c. Visual Inspection. At the time of the visual inspection, no conditions were observed that would indicate that the outlet capacity would be significantly reduced during a flood occurrence. Observations regarding the downstream channel, spillway condition and reservoir are located in Appendix B.

d. Overtopping Potential. The design folder included flood routing of the 12-hour PMF through the structure. However, the hydrologic and hydraulic design are considered inadequate because the as-built spillway differs from the designed spillway and the upstream dam was not included in the flood routing. Therefore, the overtopping potential of Lake Wynonah Dam was evaluated using some original data judged valid and approximate methods as shown in Appendix C.

Evaluation of overtopping considered the following points.

1. The peak PMF inflow for the uncontrolled portion used the original six-hour PMF inflow transposed to a smaller drainage area.

2. The maximum outflow from Fawn Lake Dam was added to the peak PMF from Step No. 1.

3. The total volume of inflow was estimated from the original design run-off volume less the available flood storage in Fawn Lake.

4. The spillway discharge capacity was estimated from as-built geometry.

5. The short-cut flood routing method described in the preliminary Engineering Letter No. 1110-2, dated 25 January 1978 was used. Based on this data and the analysis presented in Appendix C, it is concluded that Lake Wynonah Dam will not be overtopped during the PMF.

e. Spillway Adequacy. The spillway system for Lake Wynonah Dam is considered "Adequate." The embankment will not be overtopped during the passing of the estimated PMF. The tailwater is estimated to be 85 feet or more below the top of the dam during the passing of the PMF.

f. Downstream Conditions. Approximately 250 feet downstream from the axis of the dam, discharge flows through a 4.8 by 30 foot bridge under LR 53007. This bridge is expected to be flooded when discharge from the dam is equal to or greater than 1400 cfs. In the immediate area of this bridge are three homes which would be flooded when the depth of flow is 2 feet over the bridge. These three homes and attendent structures together with the sewage plant immediately upstream of the bridge would be destroyed in case of failure.

There are 13 additional homes with several attendent structures in the flood plain of the discharge channel between points A and B as shown in Plate 1. During periods of high flow some of these homes would be damaged and all would suffer at least some damage if the dam failed. Thus, a "High" hazard classification is assigned to this dam.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual observations did not indicate any existing embankment stability problems. The riprap on the upstream slope was stable and appeared to be in good condition. Similarly, the vegetation on the downstream slope was thick and distributed evenly over the embankment slope. The embankment crest did not indicate that distortions or movement of the embankment were occurring.

Seepage was noted along the downstream toe and in other areas beyond the toe were previously inspected and assessed in 1974 to be non-hazardous. This same seepage was noted during this inspection and is qualitatively assessed to be similar to the seepage noted during the previous inspections. Since a comparison of seepage rates over the years has not been made, a firm assessment of the seepage could not be performed.

The exposed portion of the pond drain facilities were inspected and assessed to be in good condition. The pond drain, trash racks and pipe below the structure could not be evaluated. It is reported by the Owner that the upstream section of the pond drain is inspected periodically by divers and that the trash racks are cleaned regularly.

The spillway system, which includes the weir, chute, slab and retaining walls, was inspected and, in general, found to be in good condition. Cracks and movement were observed in the wall panels and construction joints, respectively. It is assessed that the cracks noted in the retaining walls are shrinkage cracks because they were designed by ACI codes which do not provide sufficient steel for hydraulic structures. The footings for these walls were evaluated to be slightly too narrow and may be a contributing cause for panel rotations about the base of the wall. In addition, the upstream backfill consists of clayey materials which can also cause the walls to rotate. It is judged that this wall movement will probably continue because of the clay backfill. Therefore, it is recommended that these walls be monitored. Cracks noted in the spillway should be monitored and if seepage occurs, they should be sealed.

The riprapped channels below the pond drain and emergency spillways were examined and assessed to be in good condition.

b. Design and Construction Data. Available design data associated with the structural and stability calculations of the spillway were assessed and found to be reasonable. It is noted that there was not enough steel in the spillway walls to prevent shrinkage cracks, but this does not affect the stability of the wall.

Records indicate that a stability analysis was performed on the original embankment cross-section. This cross-section was a homogeneous embankment of impervious materials with a downstream chimney drain. Results of this analysis show a steady-state seepage minimum factor of safety of 1.6. A letter from G. K. Jewell Associates states that a reassessment of the stability was performed using the pervious downstream section as shown on Plate 3. The original analysis assumed a ϕ value of 34° for this impervious material. The redesigned condition used the same ϕ value for the impervious material and a ϕ of 45° for the pervious materials. These values appear to be somewhat high. Using lower friction factors, the factor of safety would be lower than 1.6. Without further investigation, it is not known what this revised factor of safety would be. Since there were no exterior signs of embankment instability and since the slopes and dam configuration are reasonable for this type of material, it is assessed that the factor of safety is at least equal to and probably greater than one.

A reassessment of seepage with the revised cross-section could not be located. However, the pervious nature of the material together with the blanket drain appears to be a reasonable method of controlling seepage through the embankment.

A review of the grouting record and evaluation of the grouting work performed by Mr. Albert Depman indicates that the foundation was sufficiently grouted to minimize underseepage. There was no evidence to indicate that this grouting was ineffective.

Construction specifications indicate that the embankment was to be constructed to at least 98 percent of the Standard Density as defined by ASTM D 698. Construction records submitted by G. K. Jewell and Associates indicates that compaction was in excess of 98 percent of the required density. There was no reason to believe that these records are inaccurate.

c. Operating Records. There are no operating records maintained for this structure.

d. Post-Construction Changes. There are no reports nor any evidence that modifications were made to this dam other than the addition of more drainage rock beyond the downstream toe.

e. Seismic Stability. This dam is located in Seismic Zone I. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the static stability analysis for the revised section could not be located and since the friction values of 34° and 45° for the impervious and pervious zones, respectively, appear to be a little high, an assessment of the seismic stability could not be performed.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. The visual inspection and review of the design and as-built documentation indicates that the dam, foundation and appurtenant structures of Lake Wynonah Dam are in reasonably good condition. The hydrologic and hydraulic computations presented in the design documents and the supplemental calculations presented in Appendix C indicates the dam will pass the PMF without overtopping. Therefore, the spillway systems of the structure are considered to be "Adequate." It is noted that during the PMF or a flow somewhat less than the PMF, significant property damage is likely downstream along Plum Creek.

The seepage discussed in Section 6 is undesirable but is reasonably controlled, but should be monitored regularly and the rates of seepage recorded. The riprap in the spillway discharge channel is expected to be stable during storms up to at least a 200 year frequency. Storms producing higher flows are expected to cause significant erosion but it is not expected to produce conditions hazardous to the structures.

The cracking and rotation noted on the spillway channel walls is undesirable but is not considered to be indicative of potentially unstable conditions. Wall rotation should be monitored regularly. A review of the calculations revealed that the ACI code when compared to Soil Conservation Service requirements does not provide sufficient temperature and shrinkage reinforcing steel for hydraulic structures. This accounts for the cracks.

b. Adequacy of Information. The available design information was comprehensive and adequate when coupled with the supplemental calculations provided in Appendix C. Construction data including the 64 photographs covering construction together with the DER inspection reports and progress reports prepared by G. K. Jewell and Associates indicate that construction was performed in accordance with specification requirements. Although stability calculations were unavailable, the constructed slopes, crest width, and types of soil used for this embankment are reasonable.

c. Urgency. It is concluded that the recommendations presented in Section 7.2 be implemented as soon as practicable.

7.2 Remedial Measures.

a. Facilities. The following recommendations are presented in order of priority, but does not infer that the latter recommendations are unimportant.

1. Displacement at joints along the emergency spillway should be monitored for movement periodically.

2. Because of the high rate of seepage, piezometers should be installed along the slope to delineate the phreatic profile so slope stability can be assessed.

3. Seepage flowing over the pond drain discharge wing walls is undesirable and the drainage system around the walls should be reconstructed to control seepage more effectively.

4. The seepage presently discharging around the pond drain outlet works and adjacent areas should be monitored for increases in flow or changes in turbidity. If conditions worsen, necessary remedial measures should be taken.

5. Cracking noted along the spillway weir should be monitored for seepage. Should seepage be observed, these cracks should be sealed. Similarly, the chute wall cracks should be monitored and cracks sealed if seepage emerges.

6. The boat launch area, located upstream of the spillway, should be assessed for the possibility of dislodging the docks or boats during storms. Measures should be taken to prevent this property from floating downstream and blocking the spillway.

7. Minimum flow requirements should be monitored by means of appropriate systems to insure that the criteria noted in the Permit are satisfied.

b. Operation and Maintenance Procedures. The Owner should also develop an inspection checklist and operation and

maintenance procedure to insure that all items are inspected, operated and maintained in accordance with the Designer's recommendations.

Because of the downstream population, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents that high flows are to be expected along the creek. If abnormally high flows are expected, procedures for evacuating persons within the flood plain should be implemented.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lake Wynonah Dam

ID # PA 00702

ITEM	REMARKS
AS-BUILT DRAWINGS	Yes. DER files contain a complete set of full size As Built Drawings.
REGIONAL VICINITY MAP	Yes. See Quad Sheet entitled "Friedensburg, Penna.", Plate 1 of Appendix E.
CONSTRUCTION HISTORY	50 B&W and Color construction photographs are in DER files.
TYPICAL SECTIONS OF DAM	Yes. These are included on the As Built drawings.
OUTLETS - PLAN	Data was included with the As Built drawings.
DETAILS	
CONSTRAINTS	Data was not available from DER or the Owner.
DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	None available, and the Owner indicated that none were recorded in their drainage area.

ITEM	REMARKS
DESIGN REPORTS	*Structural calculations were not available but the soils report was in the files. H&H computations were available and reviewed.*
GEOLOGY REPORTS	*Some geology was included in the Application Report.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*Yes. By American Realty Service Corp., Engineering Dept., dated Aug. & Sept., 1970. Data includes H&H structural, and foundation design calculations. A second set of design calculations were also included in DER files by Gannett, Fleming, Corddry and Carpenter, Inc. This data was soley hydrologic calculations dated June and July, 1970.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Report entitled " Subsurface Investigation Report, Lake Wynonah", by G. K. Jewell & Associates, dated Oct. 27,1970; 2 volumes. Files contained only Volume I. Volume I contains all data and summaries Volume II contains a "Geologic Section', Soil Classification notes and boring logs. Report did not contain structural design calculations.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Borrow sources were noted on plans, but an inspection of the site showed no evidence of the area as a fill source. It is likely the reservoir was used as a source.*

ITEM	REMARKS
MONITORING SYSTEMS	*Application Report requires a minimum release of 0.46 cfs (297,000 gpd)*
MODIFICATIONS	*The chimney drain was eliminated from the original design by G.K. Jewell & Associates.*
HIGH POOL RECORDS	*None. The Owner's do not maintain records.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None known.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None.*
MAINTENANCE OPERATION RECORDS	*None.*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*Details, Sections and Plans are shown on the drawings.*
OPERATING EQUIPMENT PLANS & DETAILS	*Operation manuals were not available. The drawings contain details of these items.*
SPECIFICATIONS	*"Specifications for Lake Wynonah Dam at Lake Wynonah, Inc., Schuylkill County, Pa.", Sept., 1970. 38 page specification.*
MISCELLANEOUS	*1) "Report Upon the Application of Lake Wynonah, Inc. and/or American Realty Services Corp.", dated Nov. 25, 1970.* *2) Application to Delaware River Commission, Docket NO. D-71-11, dated July 28, 1971* *3) Miscellaneous letters and correspondence from which the construction history and minor design changes could be ascertained.* *4) Grouting records are included in DER files.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Lake Wynonah Dam* County *Schuylkill* State *Pennsylvania* National ID # *PA 00702*

Type of Dam *Earth Fill* Hazard Category *I (High)*

Date(s) Inspection *11 July 1978* Weather *Clear and Warm* Temperature *80's*

Pool Elevation at Time of Inspection *639. ±* M.S.L. Tailwater at Time of Inspection *546. ±* M.S.L.

Inspection Personnel:

Brady Bisson *Vincent McKeever*

Mary Beck *John H. Frederick, Jr.*

John Boschuk, Jr.

John Boschuk, Jr. Recorder

Remarks:

Mr. Gerald Miller, Director of Lakes and Dams, was on site and provided assistance during the inspection.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

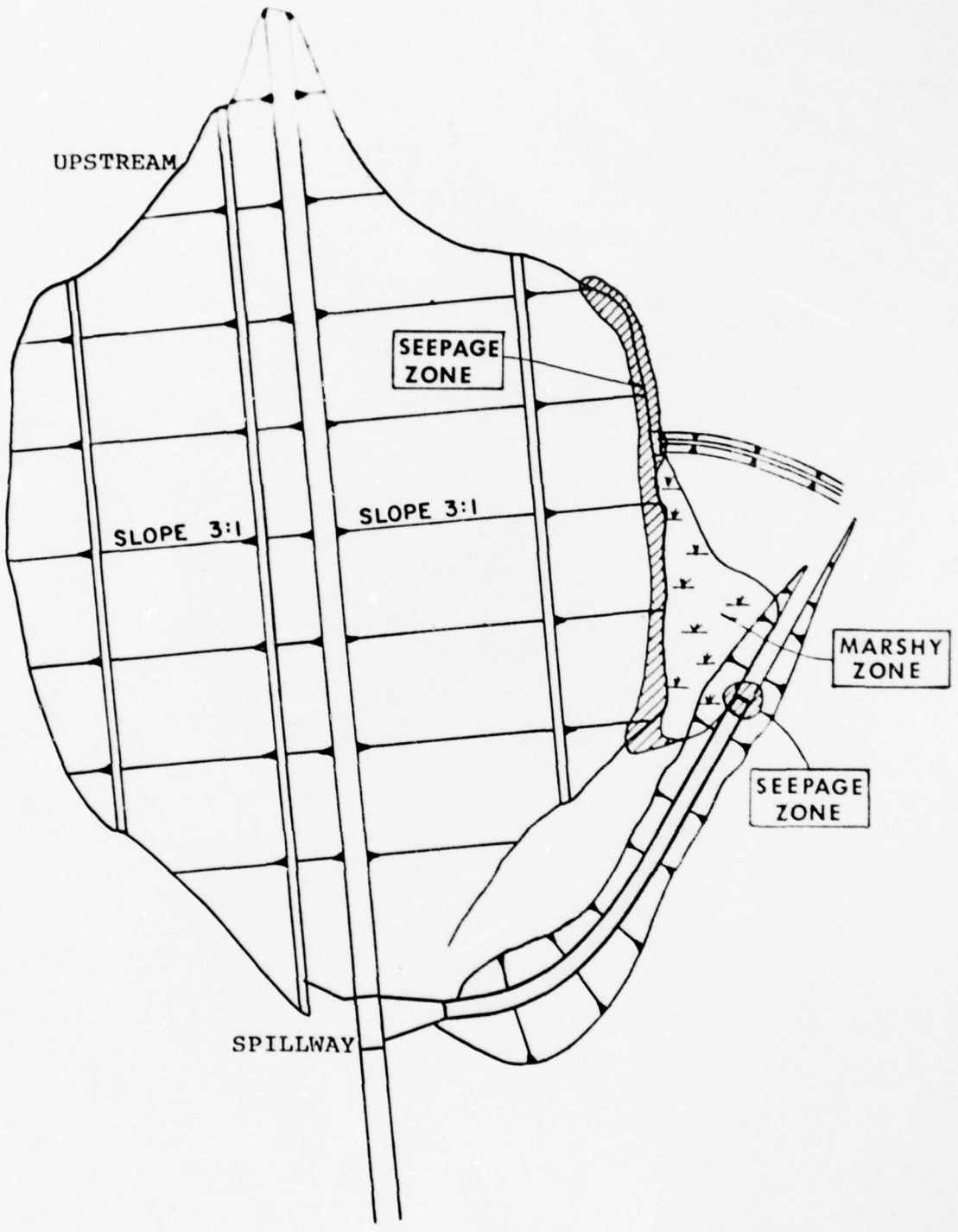
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*None observed.*	
RIPRAP FAILURES	*None observed.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*No distortion or misalignment observed.*	
ANY NOTICEABLE SEEPAGE	*Yes--See section on Outlet Systems, pages 6 and 7. Also see Sheet 5a for location of seepage.*	
STAFF GAGE AND RECORDER	*None.*	
DRAINS	*Yes--Along the emergency spillway. These drains appeared to be functioning properly. All seepage water was observed to be clear.*	



Note: Due to the type of seepage occurring (sheet flow), the quantity of flow could not be accurately estimated.

SEEPAGE LOCATION PLAN
LAKE WYNONAH DAM
SHEET 5a OF 11

OUTLET WORKS

(Pond Drain Structure)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*None observed. The conduit is buried in the embankment and could not be inspected.*	
INTAKE STRUCTURE	*Observed to be in good condition with no significant* deterioration.	
OUTLET STRUCTURE	*The impact basin was observed to be in good condition with no significant deterioration.*	
OUTLET CHANNEL	*Appears to be stable and functioning as designed.*	
SLUICE GATE	*The gate was exercised, observed to be in good condition. All fittings were greased and lubricated.*	
SEEPAGE	*Clear seepage from the toe drain exists along the sides and over the top of the impact basin. The seepage should be monitored for rate and turbidity.*	

UNGATED SPILLWAY

(Principal Spillway)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Inspection of the ogee weir disclosed cracks and deteriorated concrete, especially on the left end. Horizontal cracks showed evidence of past seepage through the cracks. All cracks should be repaired.*	
APPROACH CHANNEL	*The riprapped slopes are in good condition and are stable. However, the wing walls have rotated inward at the top. Several cracks were observed on the interior sides of the walls including several diagonal shear cracks. These cracks should be monitored and if cracking increases, they should be repaired.*	
DISCHARGE CHUTE	*Chute walls have several cracks including several diagonal shear cracks. An opening of approximately two inches was observed at several construction joints in the chute floor. The cracks should be monitored and if they increase or begin to seep, the cracks and open joints in the floor should be repaired.*	
BRIDGE AND PIERS	*A 38 foot bridge carries the road over the spillway; the pier is located approximately 8 feet below the crest of the weir and should not restrict the spillway discharge. The bridge is in good condition but shrinkage cracks were observed at the top of the bearing block on the pier. These cracks do not appear to be detrimental to the performance of the bridge.*	
SEEPAGE	*Controlled, clear seepage was observed flowing from 6 inch plastic pipes embedded in gravel adjacent to the walls at the chute outlet. The right side contained two pipes and the left side contained one pipe. The flow should be monitored for flow rate and turbidity.*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None.*	
OBSERVATION WELLS	*None.*	
WEIRS	*None.*	
PIEZOMETERS	*None.*	
OTHER	*None.*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Moderate to steep. Well vegetated with homes along the bank. Owners Association requires homes to be at least 50 feet from the shoreline. Very minor erosion due to wave action was noted along shoreline. No noticable debris was observed. Where slopes are flat some homes will be damaged by water during the PMF event.*	
SEDIMENTATION	*Sedimentation is very minor and has no effect on flood storage capacity.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*Heavy growth including trees were observed along the channel and occasionally within the 200 foot wide flood plain. The downstream channel passes through a 30 foot by 4.75 foot bridge opening under Schuylkill Mountain Road 300 feet downstream from the toe of the dam. In the next 1.5 miles downstream, there are several (6-10) private bridges, a 28 foot by 4 foot highway bridge is 1.5 miles downstream. It is expected that the private bridges will be damaged and highway bridges will be overtopped during heavy flows.*	
SLOPES	*The valley gradient is approximately 0.8 percent. The channel side slopes vary from 5:1 to 1.5:1. The bottom is stony (coarse gravel).*	
APPROXIMATE NO. OF HOMES AND POPULATION	*Immediately downstream of the dam are three homes and a sewage treatment plant (serving Lake Wynonah property owners) which would be subject to flooding during high flows and damaged if the dam failed. There are 13 more homes with several attendent farm buildings adjacent to the channel in the next 1.5 miles downstream. It is estimated that less than 100 people reside in the flood plain between points A and B shown on Plate 1.*	

APPENDIX

C

LAKE WYNONAH DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Approx. 1/3 wooded, approx. 1/3 developed with homes, Approx. 1/3 of total D.A. controlled by upstream dam.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *640.0 (5738 Acre-Feet)*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *649.0 (7477 Acre-Feet)*

ELEVATION MAXIMUM DESIGN POOL: _____

ELEVATION TOP DAM: *649.0*

SPILLWAY:

a. Elevation *640.0*

b. Type *Ogee weir*

c. Width *40 feet with a 1 1/2 foot bridge pier.*

d. Length ------

e. Location Spillover *Right abutment.*

f. Number and Type of Gates *None*

POND DRAIN:

a. Type *RCP with drop inlet flush with embankment.*

b. Location _____

c. Entrance inverts *561.3*

d. Exit inverts *544.4*

e. Emergency draindown facilities *The pond drain.*

HYDROMETEOROLOGICAL GAGES:

a. Type *None*

b. Location _____

c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: *1400 cfs.*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 7/27/78
By: MFB
Sheet: 2 of 10

DAM Lake Wynonah Dam Nat. ID No. PA00702 DER No. 54-176

ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1. Min. Crest Elev., ft.	649.0		
2. Freeboard, ft.			
3. Spillway(1) Crest Elev, ft.	640.0		
3a. Secondary(2) Crest Elev, ft.			
4. Max. Pool Elev., ft.			
5. Max. Outflow(3), cfs			
6. Drainage Area, mi^2	3.04		3.04
7. Max. Inflow(4), cfs	2600 (PME)		
8. Reservoir Surf. Area, Acre	125		
9. Flood Storage(5), Acre-Feet	1789		
10. Inflow Volume, ft^3			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

Date: 7/27/78
By: MFB
Sheet: 3 of 10

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from Sheet 2)	Source
1A, 5A	Drawings prepared by American Realty Service dated
6A, 7A, 8A, 9A	Design Calculations, Vol. I prepared by Gannett Fleming Corddry & Carpenter, dated July 1970
6C	USGS Map Friedensburg (1968)

Classification (Ref: Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as HIGH as there would be loss of life if the dam failed
2. The size classification is INTERMEDIATE based on its height and storage.
3. Spillway design flood, based on size and hazard classification, is the probable maximum flood (PMF).

Hydrology and Hydraulics Analysis

1. Design Data and evaluation
   a. The drainage area = 3.04 sq. miles. (The design did not consider the upper 0.98 sq. miles is controlled by Fawn Lake Dam)
   b. Two spillway systems were evaluated, neither of which appears on the plans nor was built
   c. The 6-hr and the 12 hr PMF storm hydrographs were developed, with peak inflows of 7700 cfs and 6600 cfs respectively. The calculations are judged adequate for the assumptions. See sheet 7.
   d. Several flood routings were performed but none for the final spillway design.
2. Spillway Capacity
   a. The spillway as built is a 40 ft. long concrete ogee weir with one 18 inch thick bridge pier located 5.9 ft. downstream of spillway
      From Hydraulic design book, $H_o = 6$ ft. & $P = 3$ ft.
      From "Design of Small Dams", fig. 249, $C_o = 3.8$.

From H_e = 9 ft. (maximum possible head) and fig. 250, C = 1.06 × 3.8 = 4.028

The bridge pier is probably far enough below the spillway crest to have no effect on spillway discharge, however, conservatively assume the effective length of the weir is 38 ft. (Application Report, dated Nov. 25, 1970

b. $Q = CLH^{3/2}$

$4.028 \cdot 38 \cdot 9^{3/2} = 4133$ cfs

3. Short-Cut Flood Routing (see sheets 9 & 10)

a. Volume of inflow -
from the design book runoff = 25" for the 6-hr PMF

$\frac{25}{12} \cdot 3.04 \cdot 640 = 4053$ Ac-Ft

available storage in Fawn Lake = 333 Ac-Ft

Total Inflow = 3720 Ac-Ft.

b Peak Inflow -
from the design book, Q_I = 7700 cfs for D.A. = 3.04 mile²

$\left(\frac{3.04 - 0.98}{3.04}\right)^{0.8} 7700$

therefore, Q_I = 5640 cfs

from information supplied by Corps of Engineers, Baltimore District -
compare Lake Wynonah watershed to West Branch of Schuylkill -
D.A. = 48 sq. mile PMF = 7200 cfs

$\left(\frac{3.04 - 0.98}{48}\right)^{0.8} 7200 = 3660$ cfs

Therefore Q_I = 5640 cfs is conservative and will be used.

Peak Inflow is 5640 + the maximum outflow of Fawn Lake Dam or 1522 cfs

Peak Inflow = 7162 cfs

c. Available storage in Lake Wynonah Reservoir is 1739 Ac-Ft.

d. Required storage in Lake Wynonah Reservoir is $\left(1 - \frac{4133}{7162}\right) 3720 = 1573$ Ac-Ft.

THEREFORE: The Dam Does Not Overtop and the Spillway is "ADEQUATE"

4. Downstream Conditions

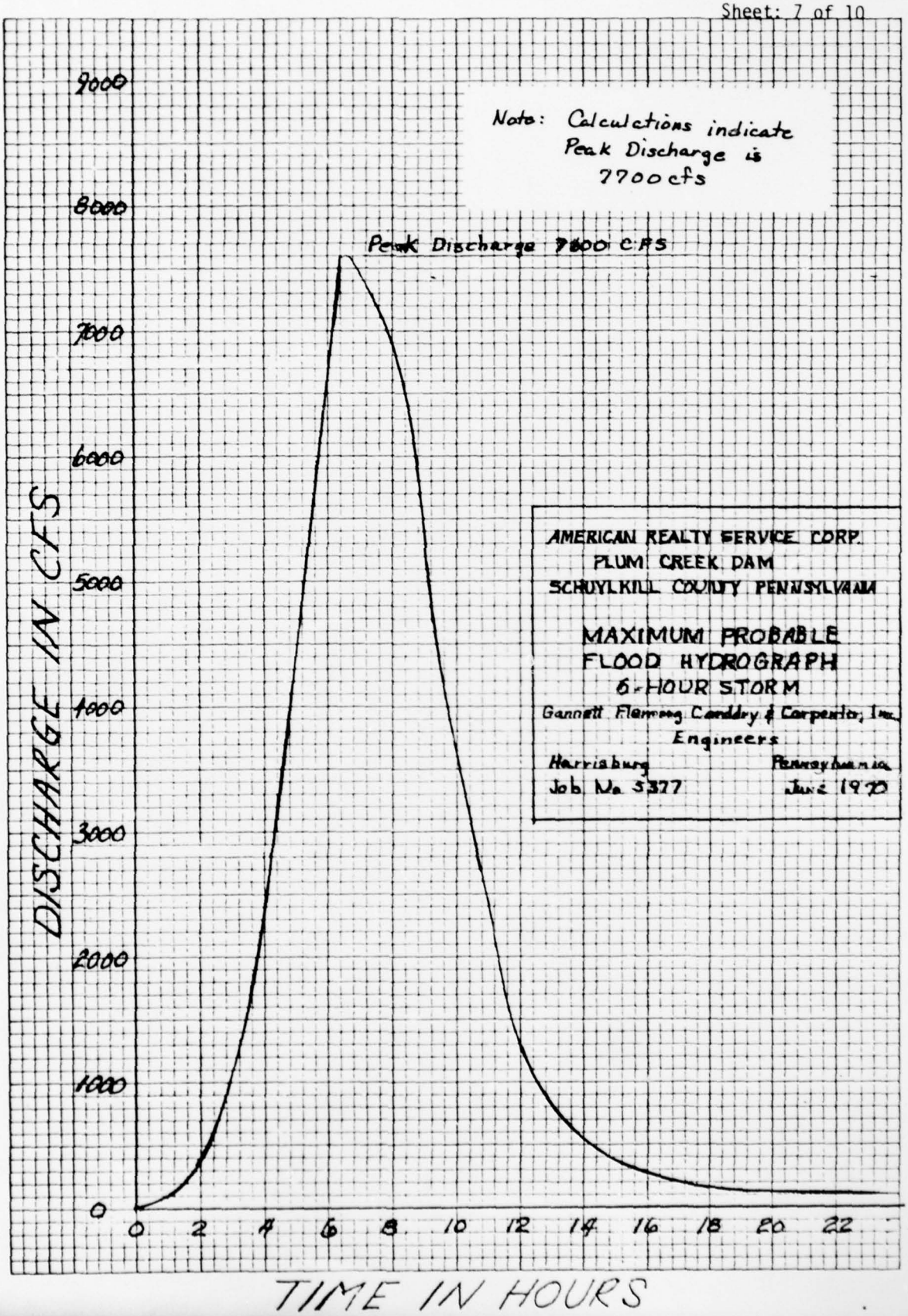
Approximately 250 ft. from the downstream toe discharge flows thru a 4 ft 9 in x 30 ft. bridge opening.

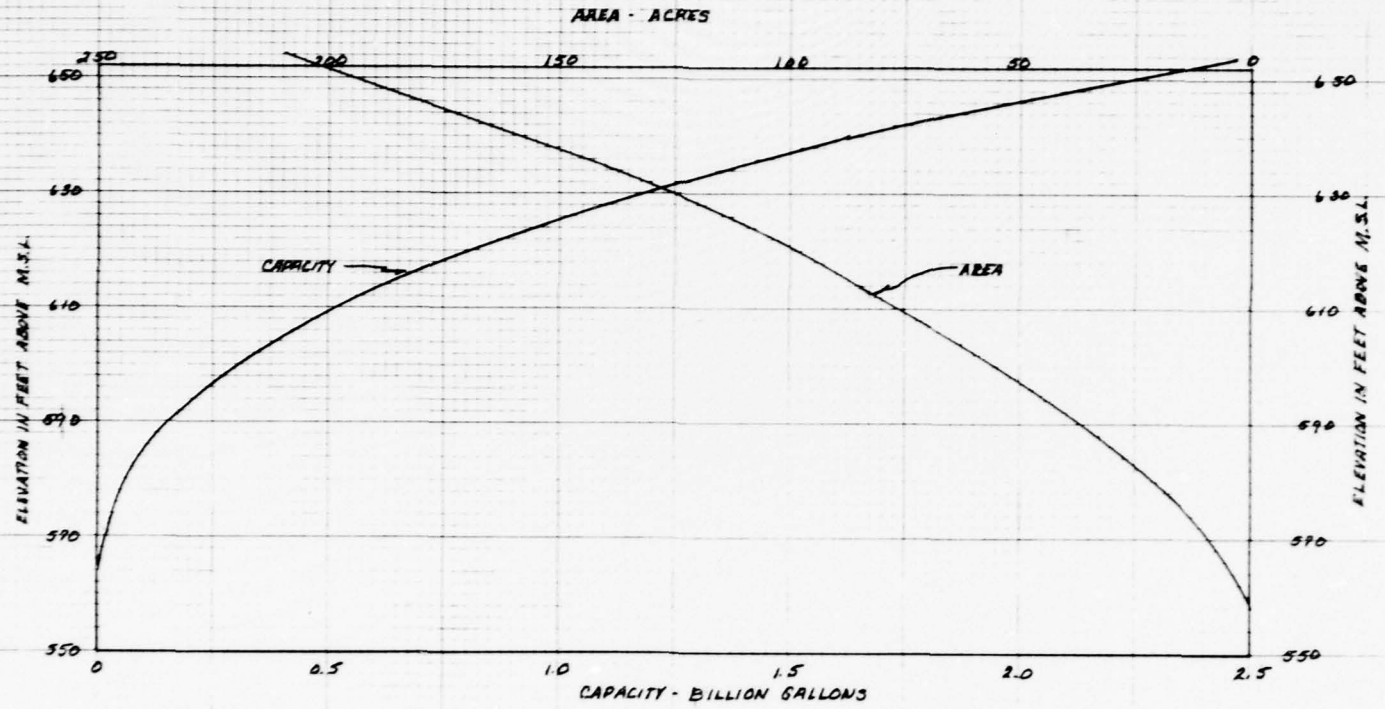
As there is only one foot between the bottom and top (roadway) of the bridge, estimate discharge by Manning's Equation

$$Q = a \frac{1.486}{n} r^{2/3} s^{1/2}$$

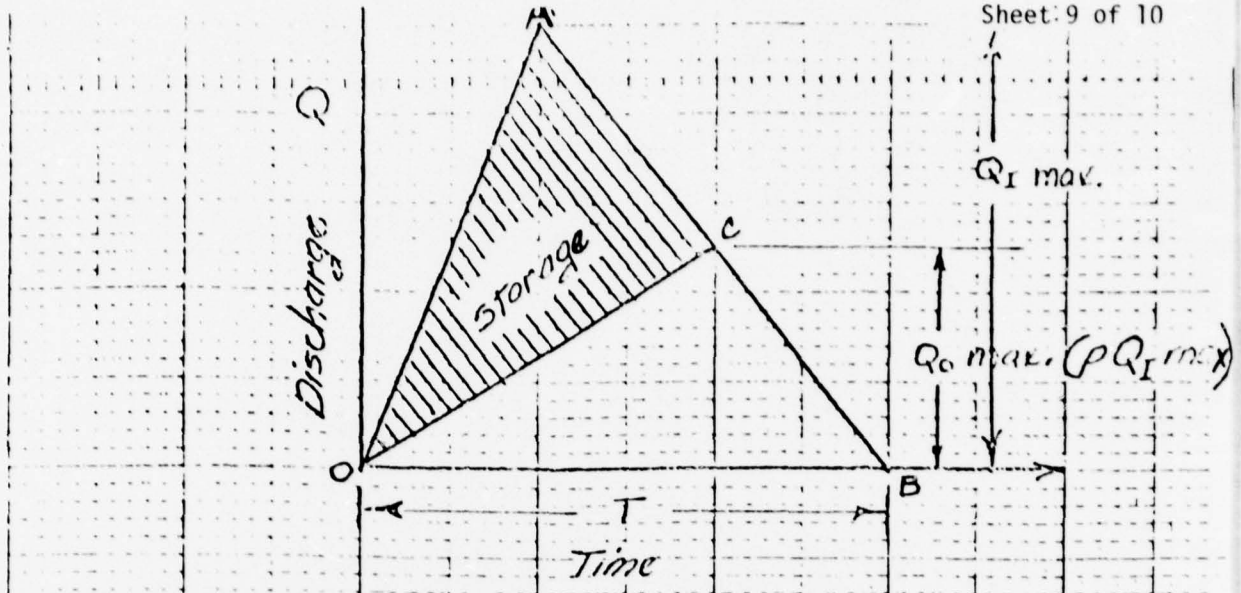
$a = 4.75 \times 30 = 142.5$ ft^2 (field measured)
$n = 0.03$ (field estimated)
$r = a/w.p. = 142.5/(30+2 \cdot 4.75) = 3.61$
$s = 0.007$ (from USGS map)

$$Q = 142.5 \frac{1.486}{0.03} 3.61^{2/3} 0.007^{1/2}$$
$$= 1390 \text{ cfs}$$


Note: Calculations indicate Peak Discharge is 7700 cfs
Peak Discharge 7800 CFS
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
DISCHARGE IN CFS
0 2 4 6 8 10 12 14 16 18 20 22
TIME IN HOURS
AMERICAN REALTY SERVICE CORP.
PLUM CREEK DAM
SCHUYLKILL COUNTY PENNSYLVANIA
MAXIMUM PROBABLE
FLOOD HYDROGRAPH
6-HOUR STORM
Gannett Fleming Corddry & Carpenter, Inc.
Engineers
Harrisburg Pennsylvania
Job No. 5377 June 1970



Reference: Design Calculations for
Lake Wyoming Dam
Vol. I, sheet 6 of 6
Gannett Fleming Corddry
& Carpenter, Inc.
June 1970



PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

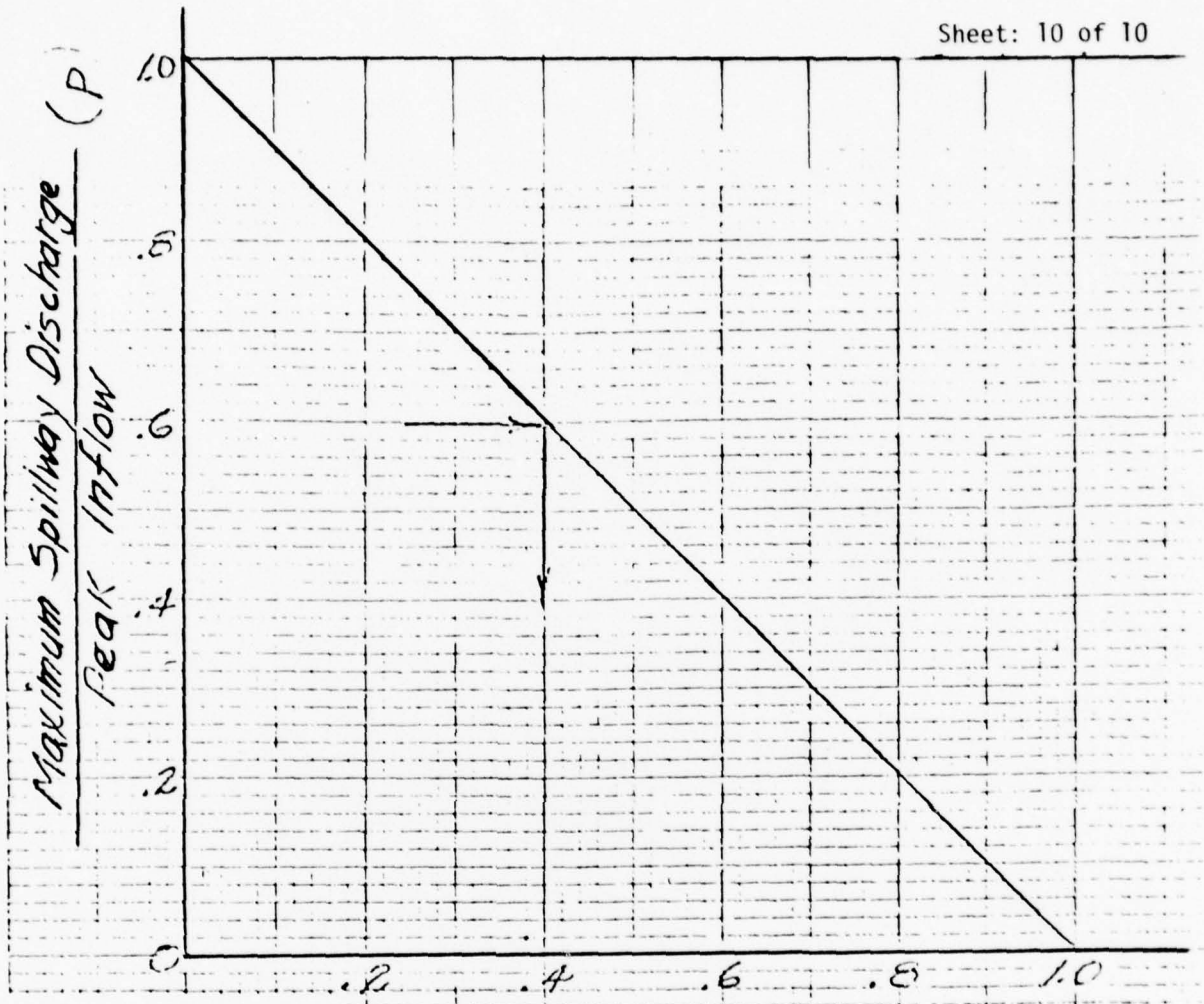
$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T \rho Q_{I\,max}/2}{T\ Q_{I\,max}/2} = 1 - \rho$$

$$\Delta AOC = (1-\rho)\,\Delta AOB \quad \text{where } 0 \le \rho \le 1.0$$

ρ	ΔAOC
1.00	0
0.75	0.25 ΔAOB
0.50	0.50 ΔAOB
0.25	0.75 ΔAOB
0	1.00 ΔAOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2-
25 January 1978



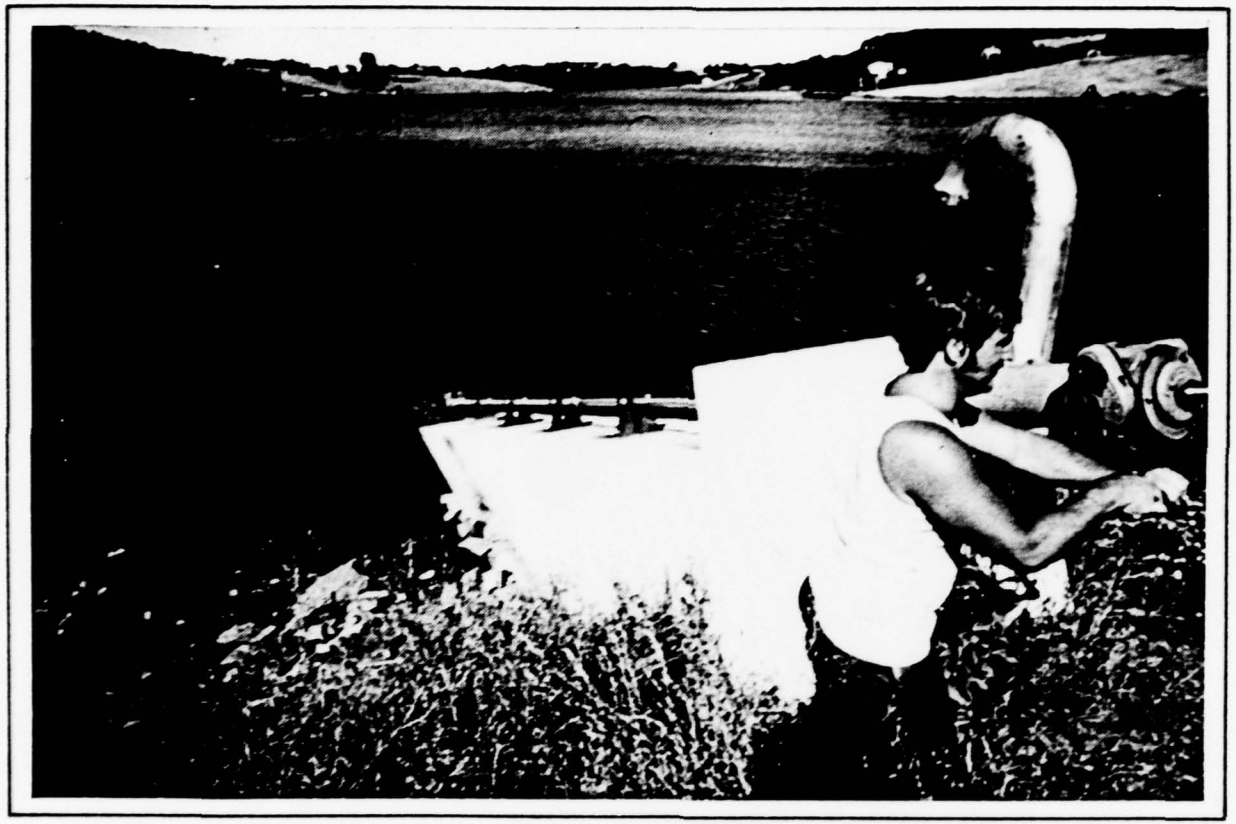
Steps to obtain required reservoir to pass inflow hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storage to volume of inflow hydrograph from curve

page 2 of 2

APPENDIX

D

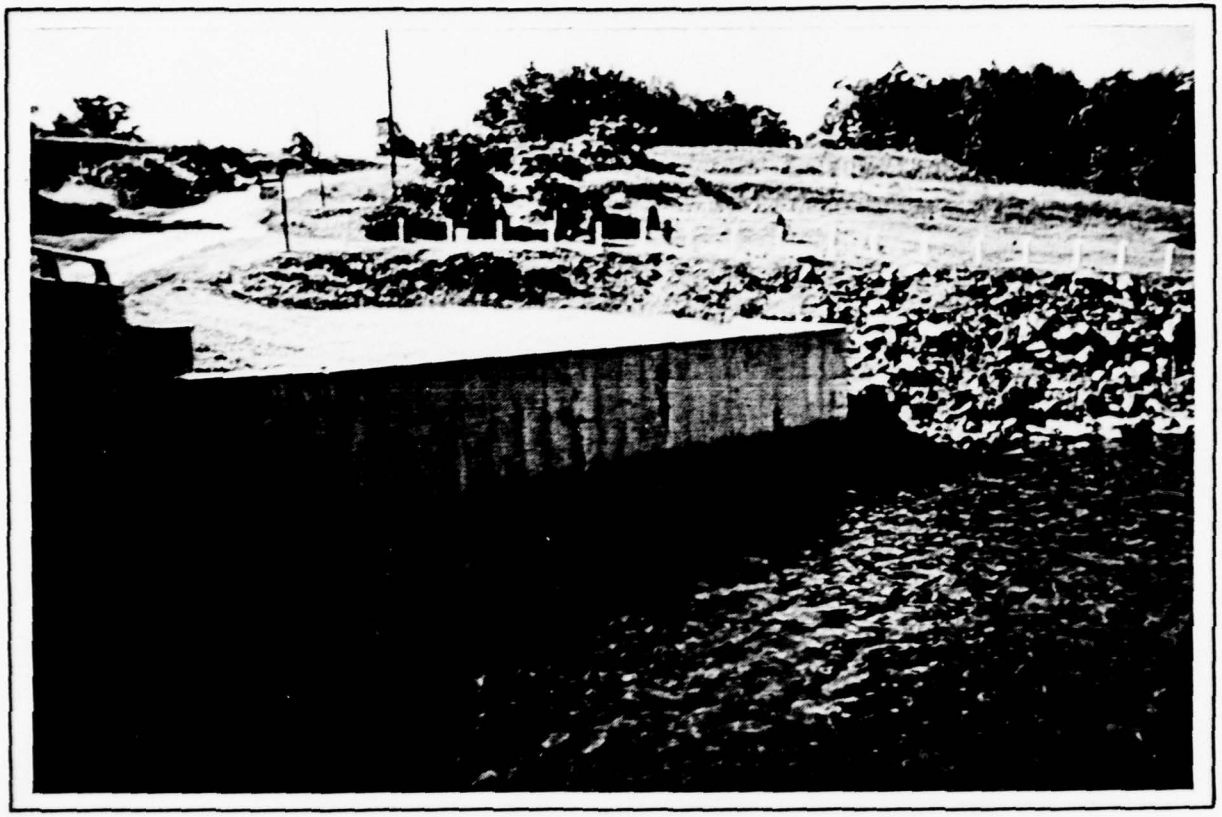


VIEW OF INCLINED POND DRAIN. AIR RISER IS SHOWN ON THE LEFT WHICH IS CONNECTED TO AN OUTLET SYSTEM WHICH MAINTAINS MINIMUM FLOW REQUIREMENTS

PHOTOGRAPH NO. 1

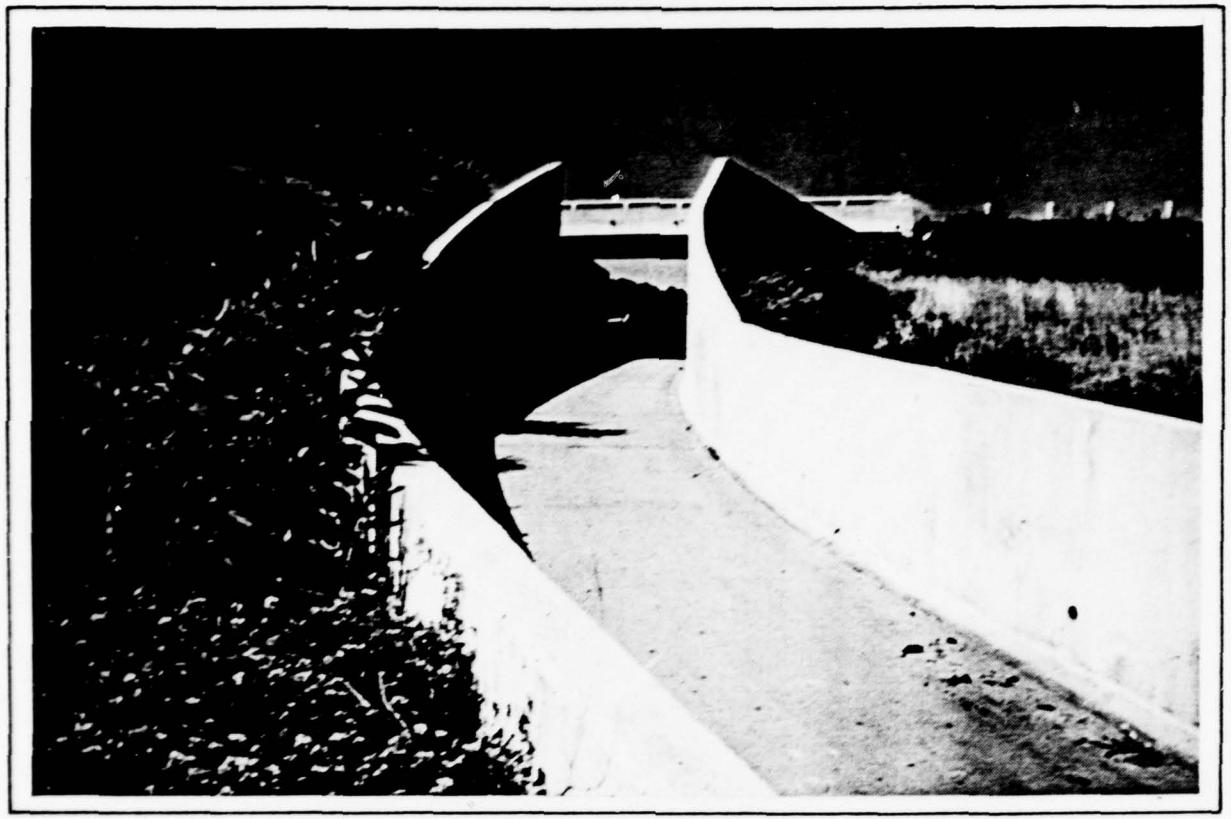
POND DRAIN OUTLET SYSTEM. GRAVEL
FROM BLANKET DRAIN CAN BE SEEN LEFT
OF THE CONCRETE STRUCTURE

PHOTOGRAPH NO. 2



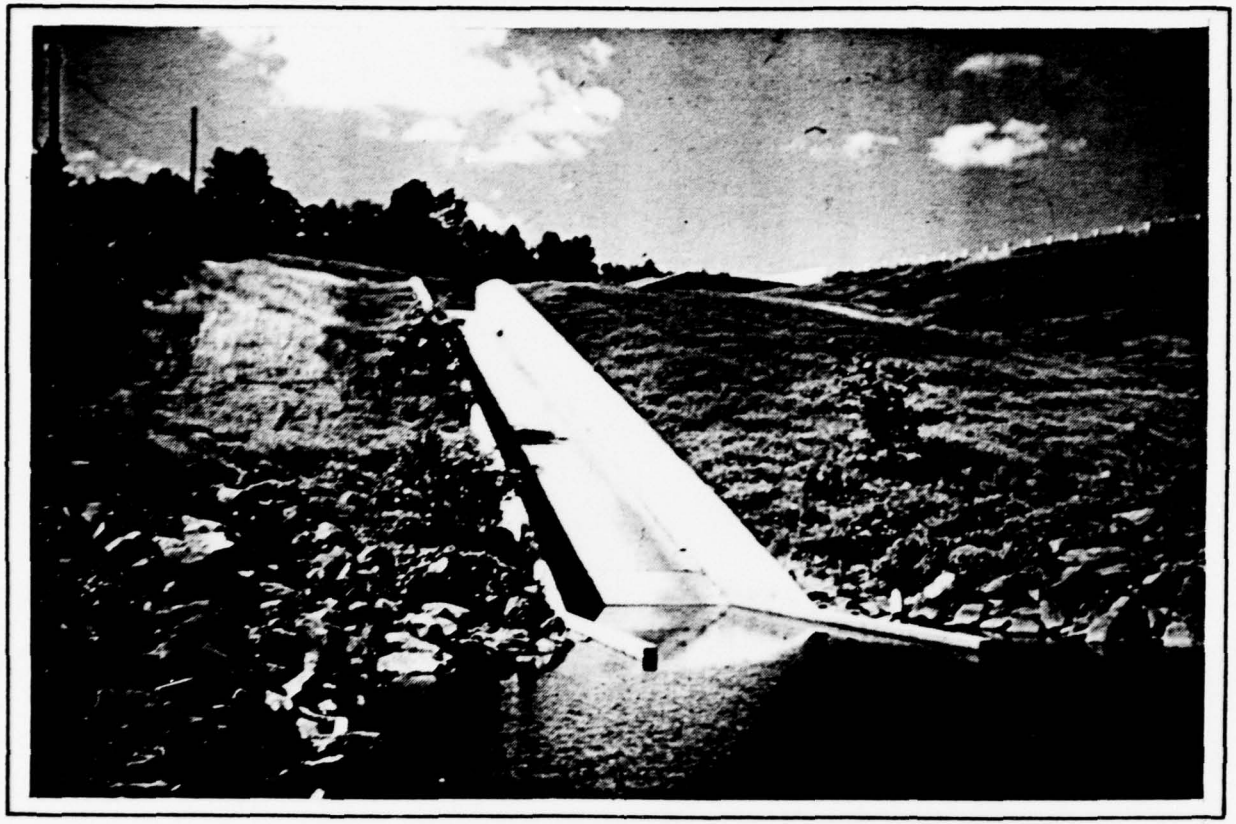
PRINCIPAL SPILLWAY INLET CHANNEL

PHOTOGRAPH NO. 3



PRINCIPAL SPILLWAY CHUTE LOOKING UPSTREAM

PHOTOGRAPH NO. 4

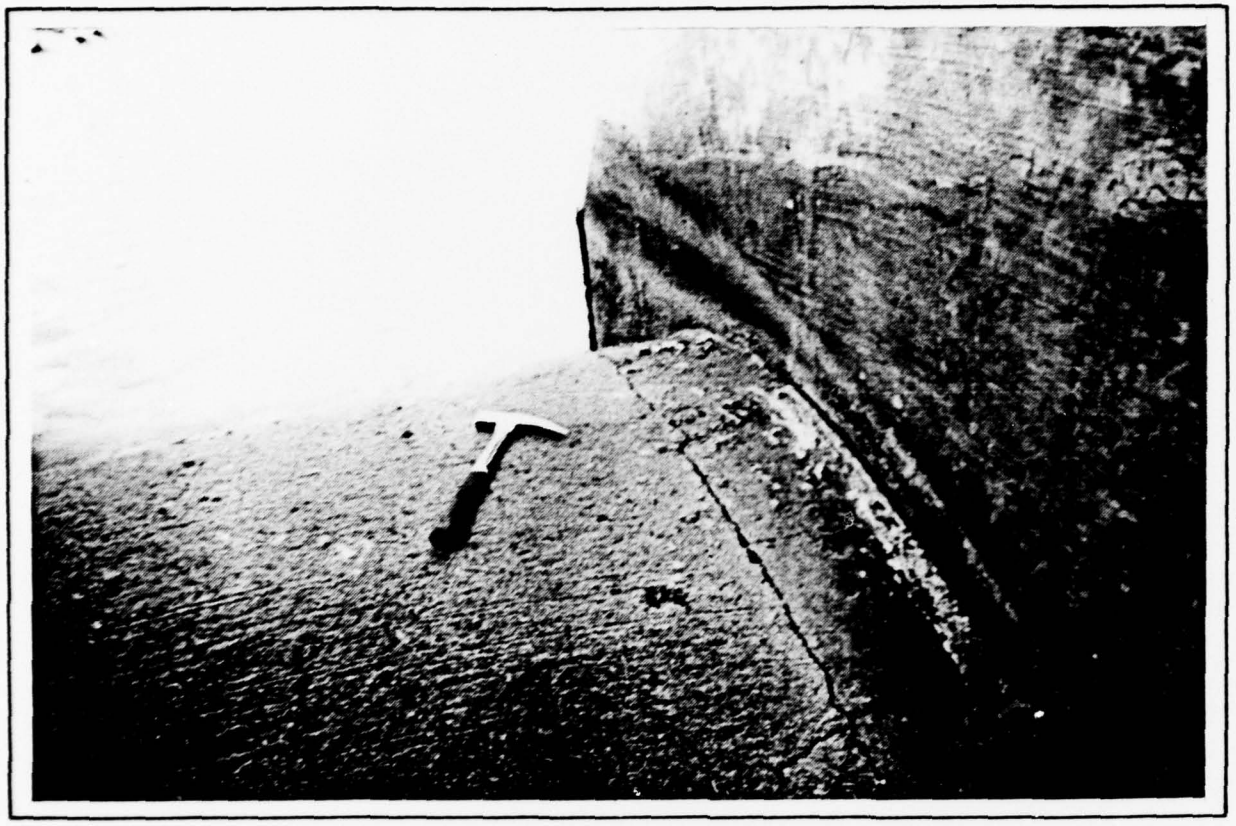


PRINCIPAL SPILLWAY CHUTE OUTLET AND
STILLING BASIN. CLEAR SEEPAGE DISCHARGES
AT BASE OF CHUTE THROUGH GRAVEL AND PIPES

PHOTOGRAPH NO. 5

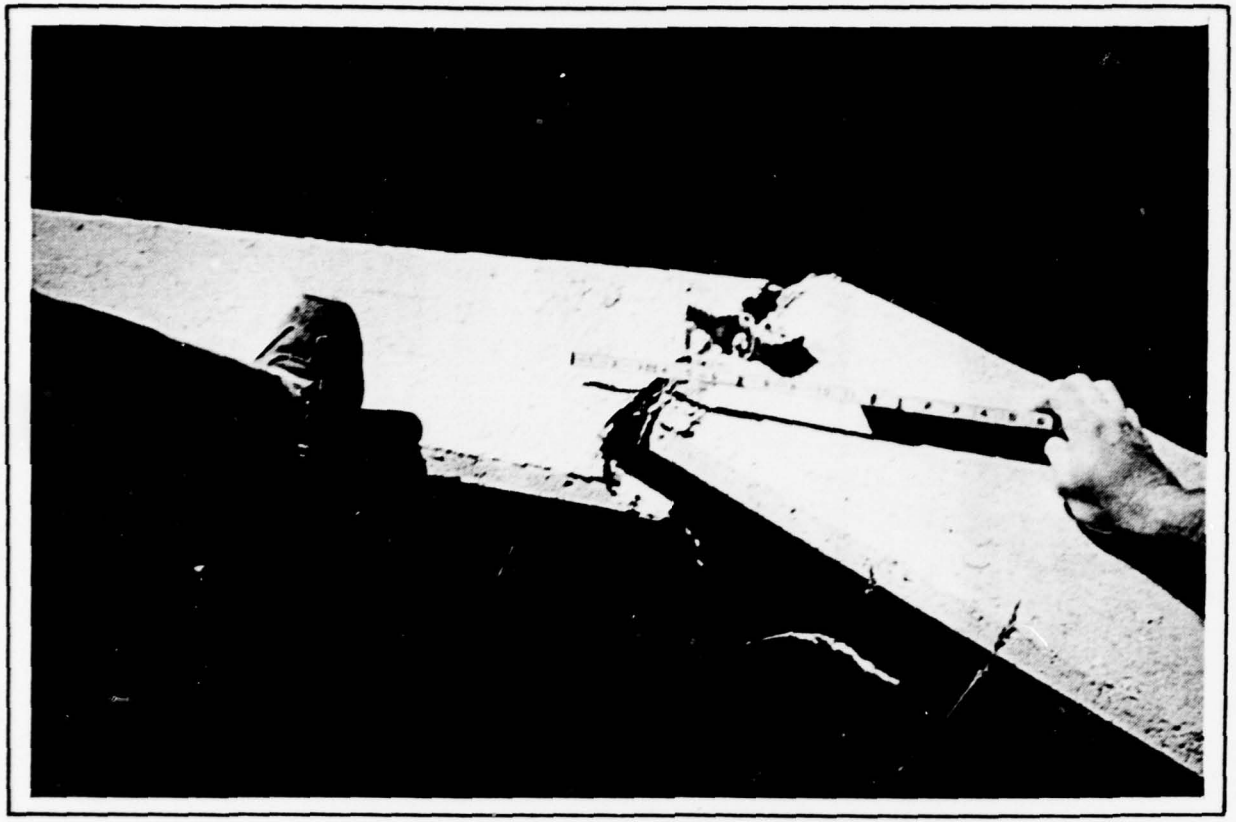
VIEW LOOKING DOWNSTREAM FROM CREST
OF DAM. NOTE HOMES AND
SEWER PLANT SUBJECT TO FLOODING

PHOTOGRAPH NO. 6



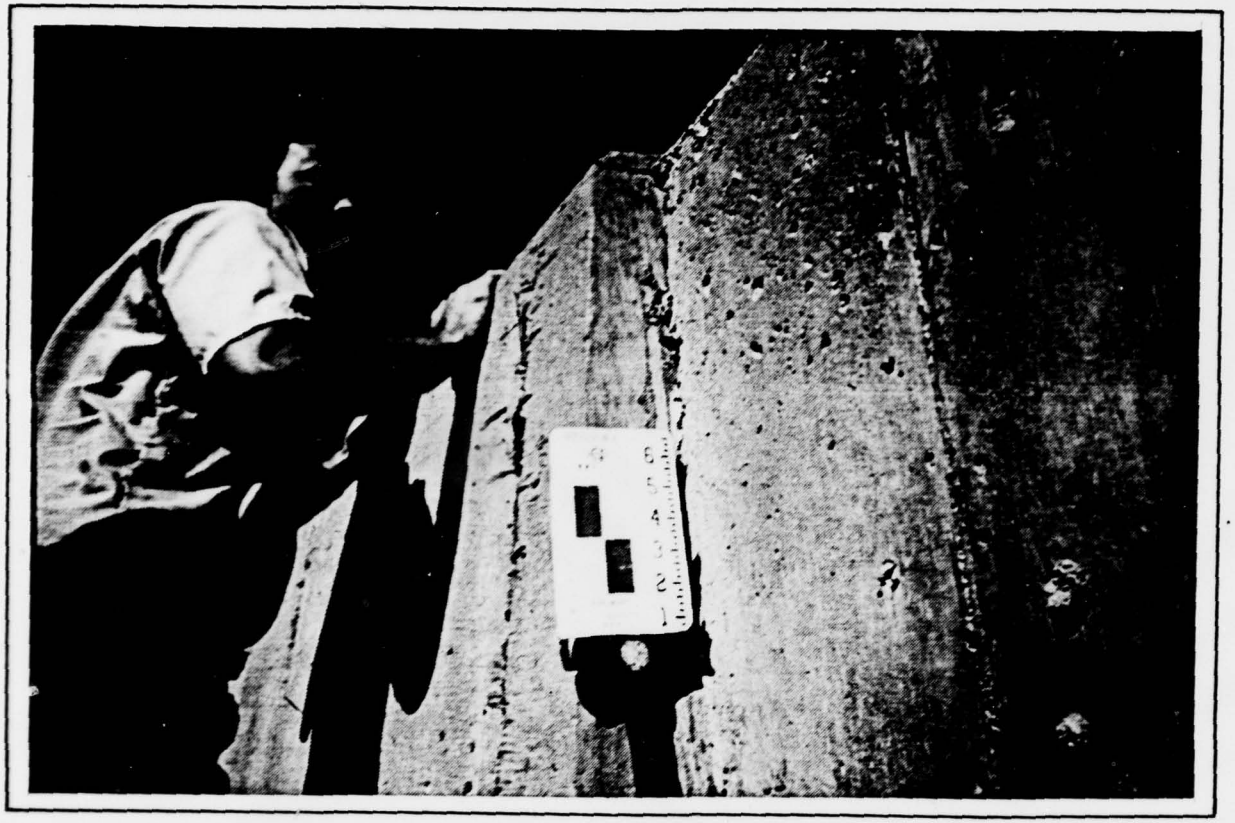
VIEW OF CRACKED OGEE SECTION
ADJACENT TO LEFT WING WALL.
HORIZONTAL CRACKS WERE NOTED FURTHER
DOWN THE WEIR. NOTE HIGH WATER
MARKS ON THE WINGWALL

PHOTOGRAPH NO. 7



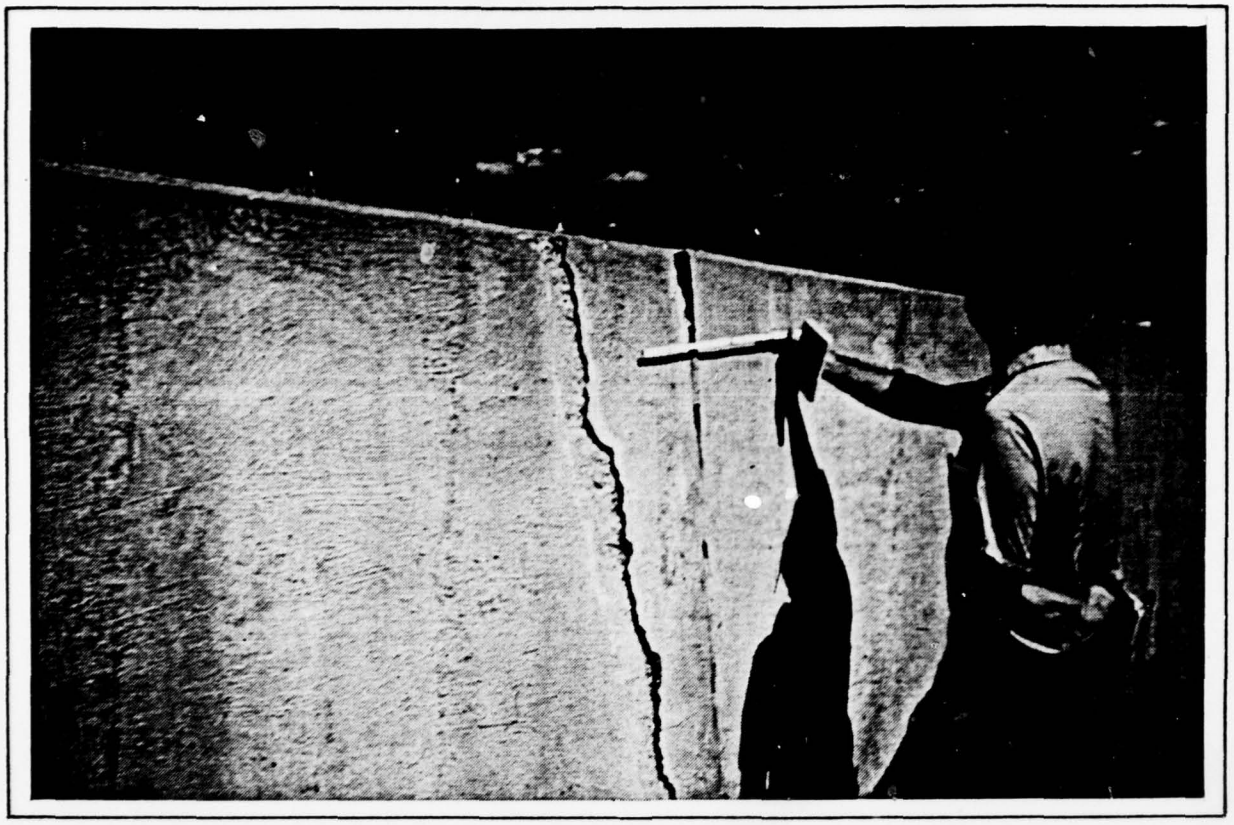
DISPLACEMENT OF WINGWALLS AT CONSTRUCTION JOINTS WERE NOTED AT SEVERAL LOCATIONS ALONG THE SPILLWAY CHUTE

PHOTOGRAPH NO. 8



DISPLACED WINGWALL ALONG CHUTE SPILLWAY

PHOTOGRAPH NO. 9

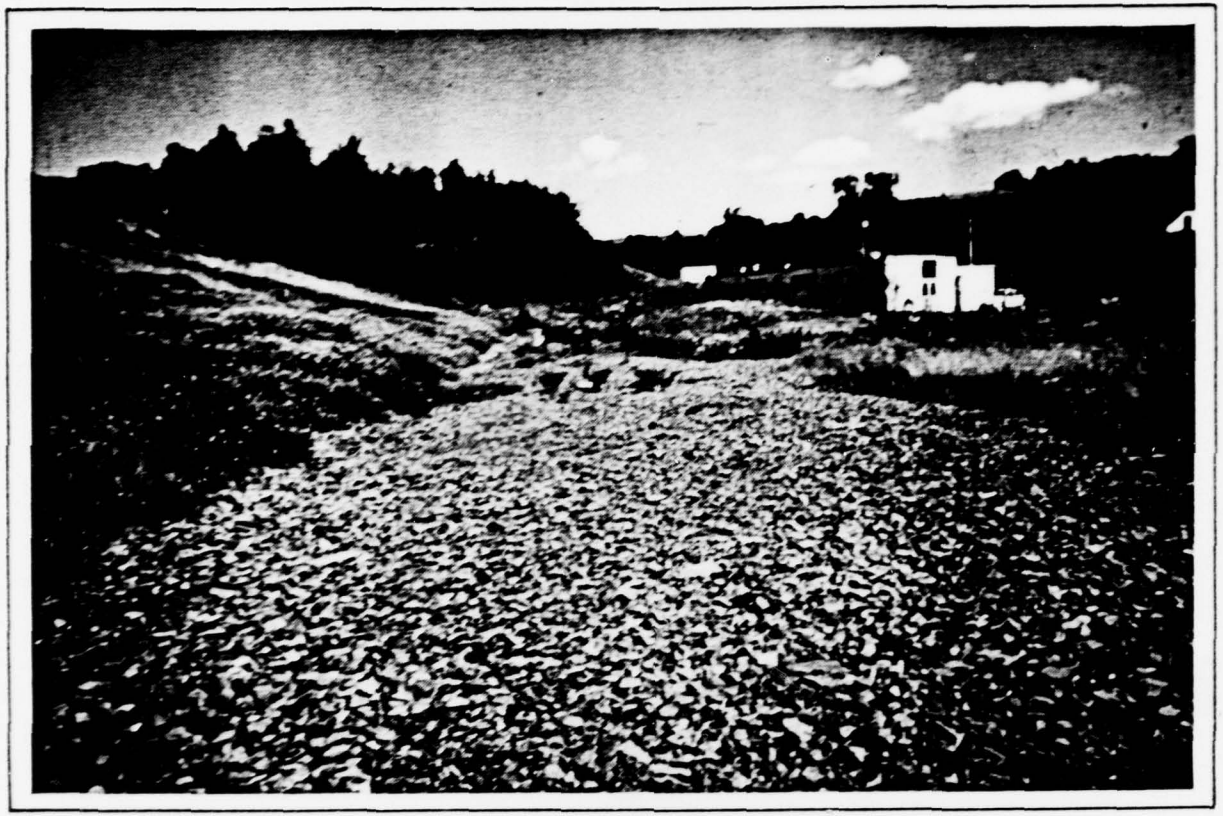


CRACKED WINGWALL ALONG SPILLWAY CHUTE

PHOTOGRAPH NO. 10

CONTROLLED SEEPAGE THROUGH 6" PLASTIC
PIPE AT BASE OF CHUTE SPILLWAY
(LEFT SIDE). VIEW LOOKING UPSTREAM

PHOTOGRAPH NO. 11



VIEW OF GRAVEL BLANKET LOOKING
TOWARDS LEFT ABUTMENT AT BASE
OF DAM. NOTE SEWAGE
TREATMENT PLANT IN BACKGROUND

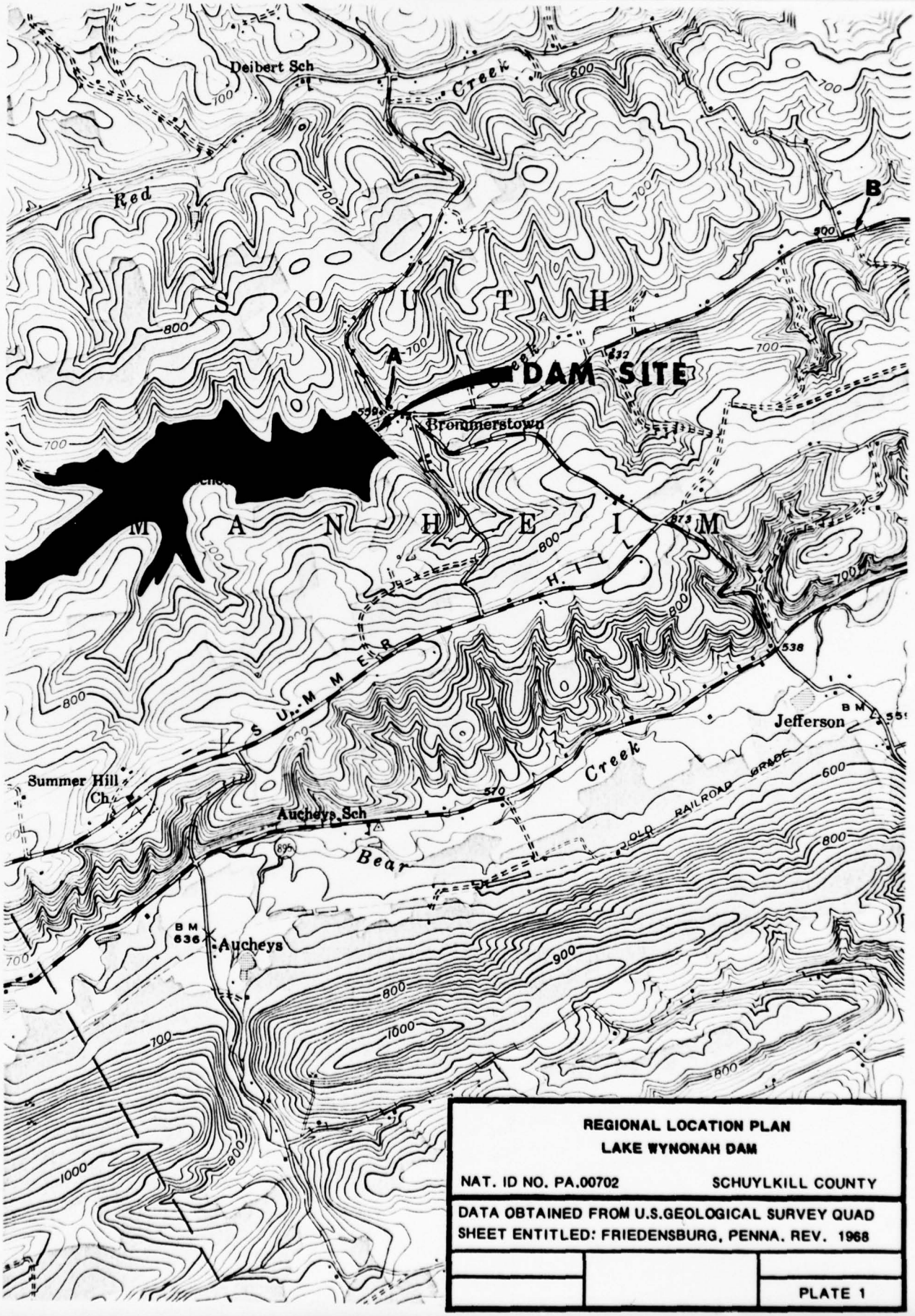
PHOTOGRAPH NO. 12

SEEPAGE THROUGH GRAVEL BLANKET DISCHARGING
OVER LEFT WINGWALL. SEEPAGE IS CLEAR

PHOTOGRAPH NO. 13

APPENDIX

E



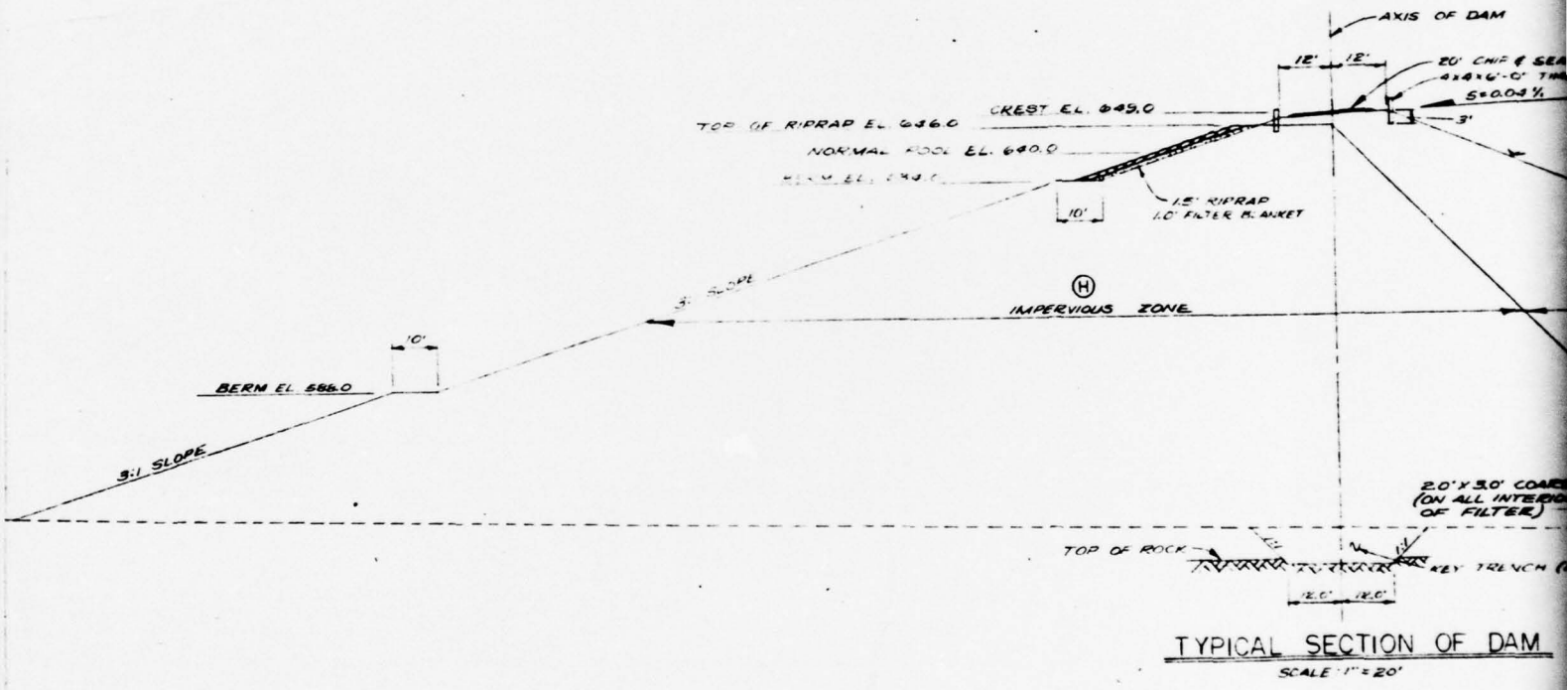
REGIONAL LOCATION PLAN LAKE WYNONAH DAM	
NAT. ID NO. PA.00702	SCHUYLKILL COUNTY
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED: FRIEDENSBURG, PENNA. REV. 1968	
	PLATE 1

PLAN OF DAM AND APPURTENANT STRUCTURES
LAKE WYNONAH DAM

NAT. ID NO. PA.00702 SCHUYLKILL COUNTY

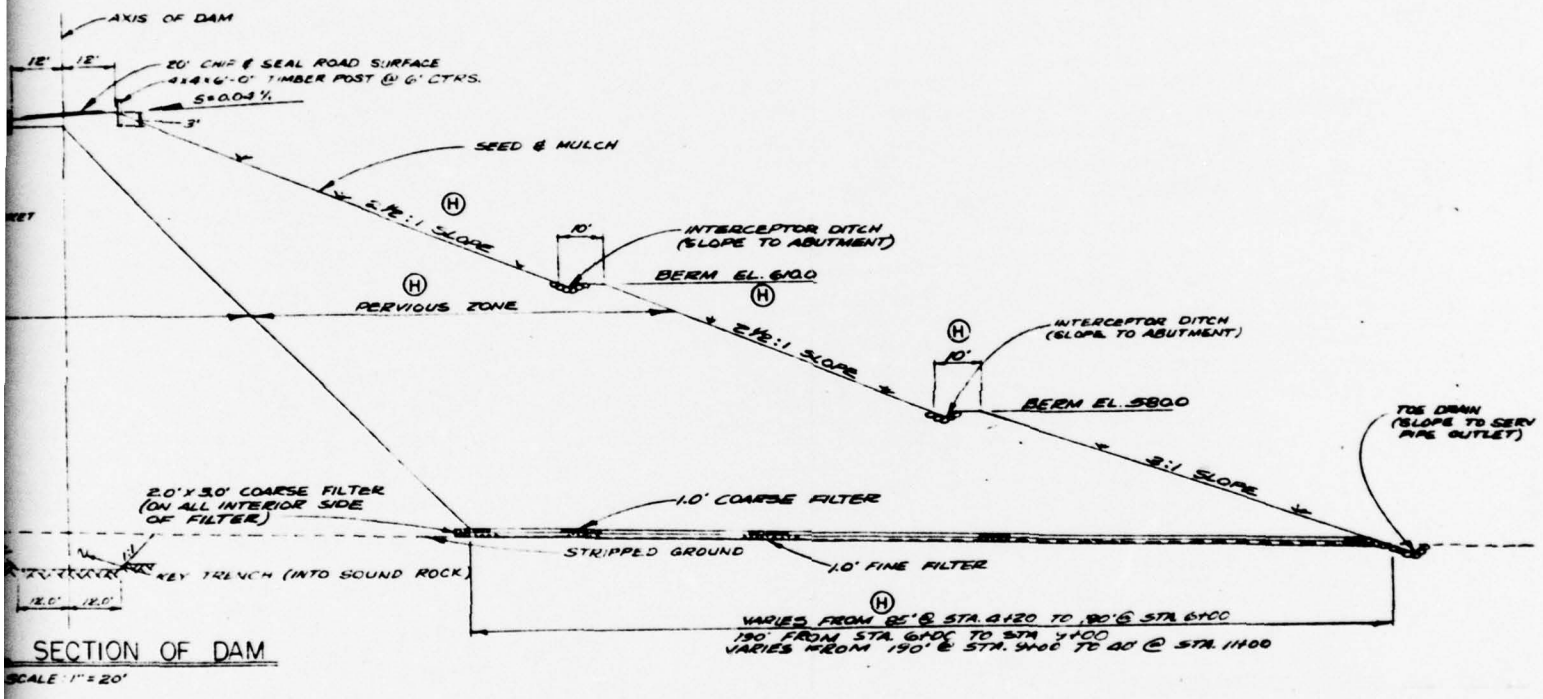
DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., MEMPHIS, TENN. DWG. NO. 7970–D–1, SHEET 1 OF 15, DATED SEPT., 1970

PLATE 2



TYPICAL SECTION OF DAM

SCALE 1" = 20'



SECTION OF DAM

SCALE: 1" = 20'

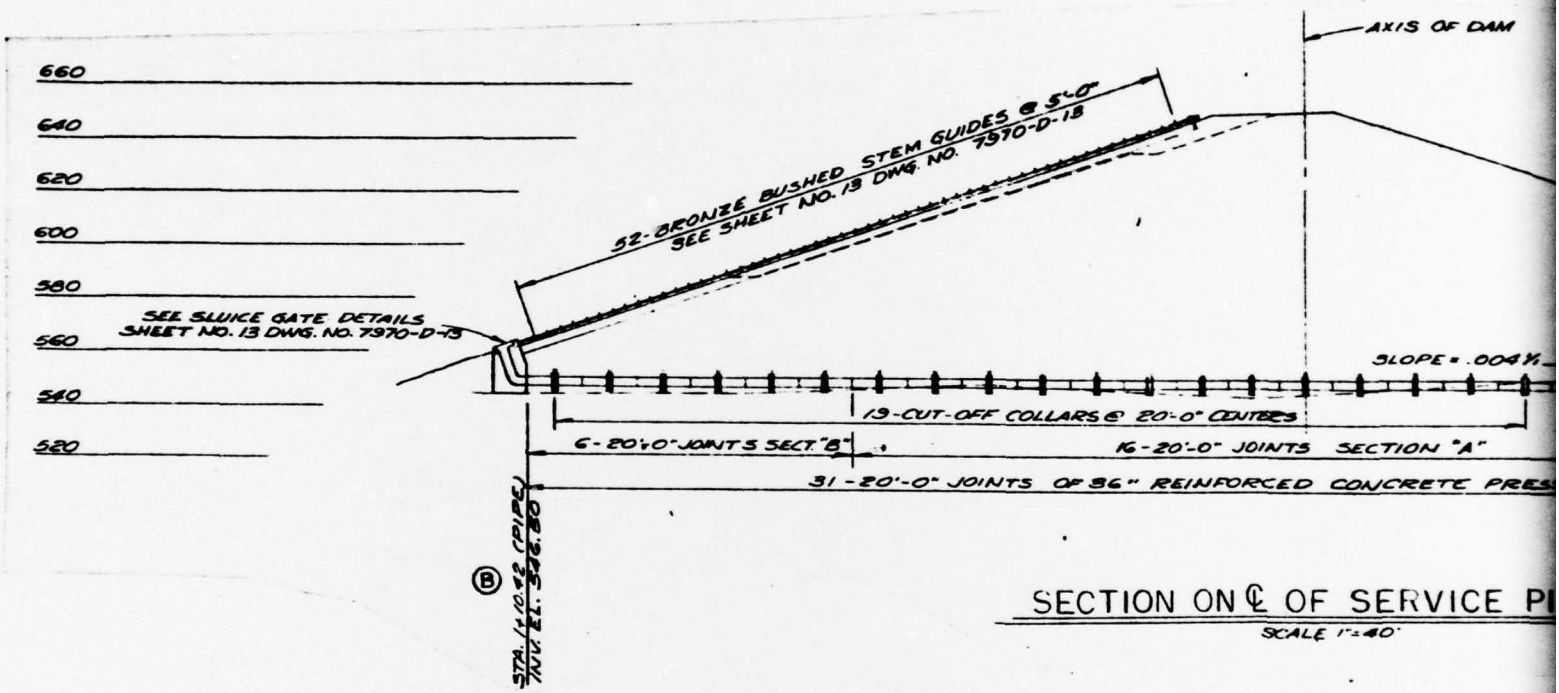
2

TYPICAL EMBANKMENT SECTION
LAKE WYNONAH DAM

NAT. ID NO. PA.00702 SCHUYLKILL COUNTY

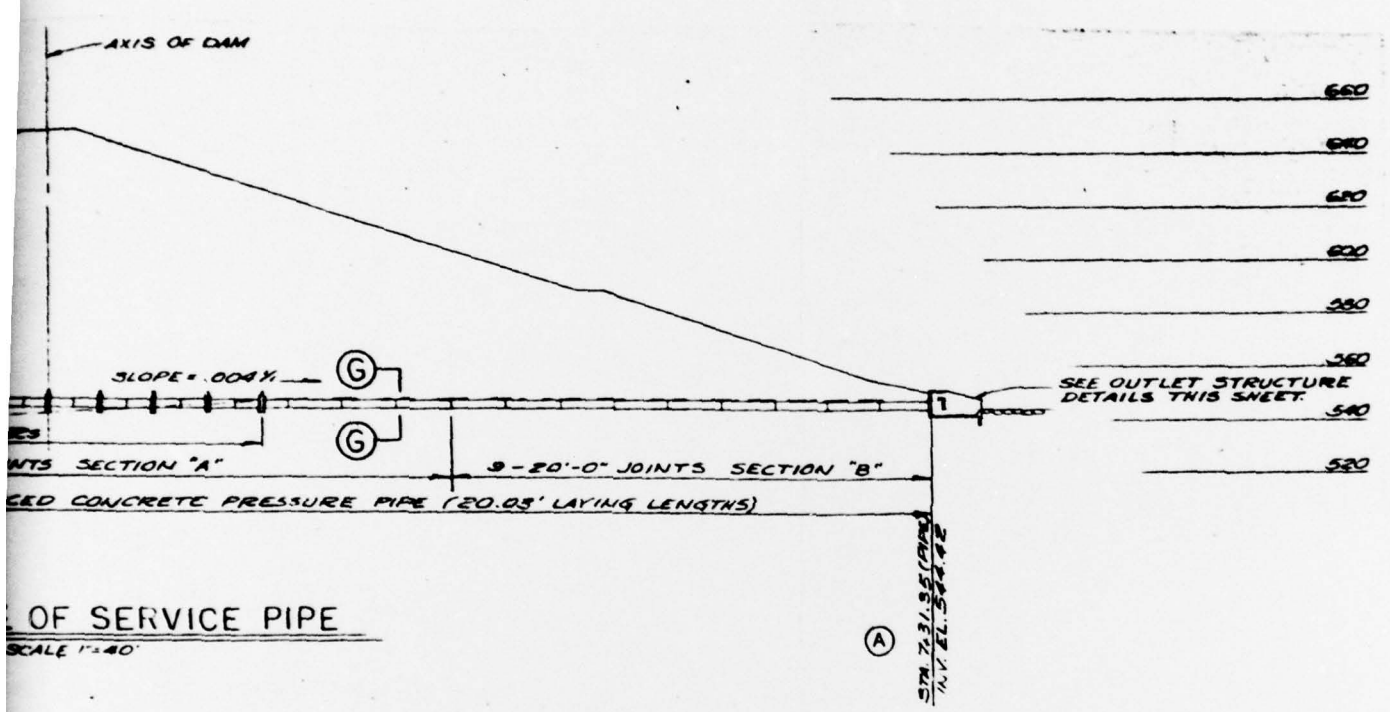
DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERNG , MEMPHIS, TENN. DWG.NO. 7970-D-2, SHEET 2 OF 15, DATED SEPT., 1970

PLATE 3



SECTION ON ℄ OF SERVICE PI

SCALE 1"=40'

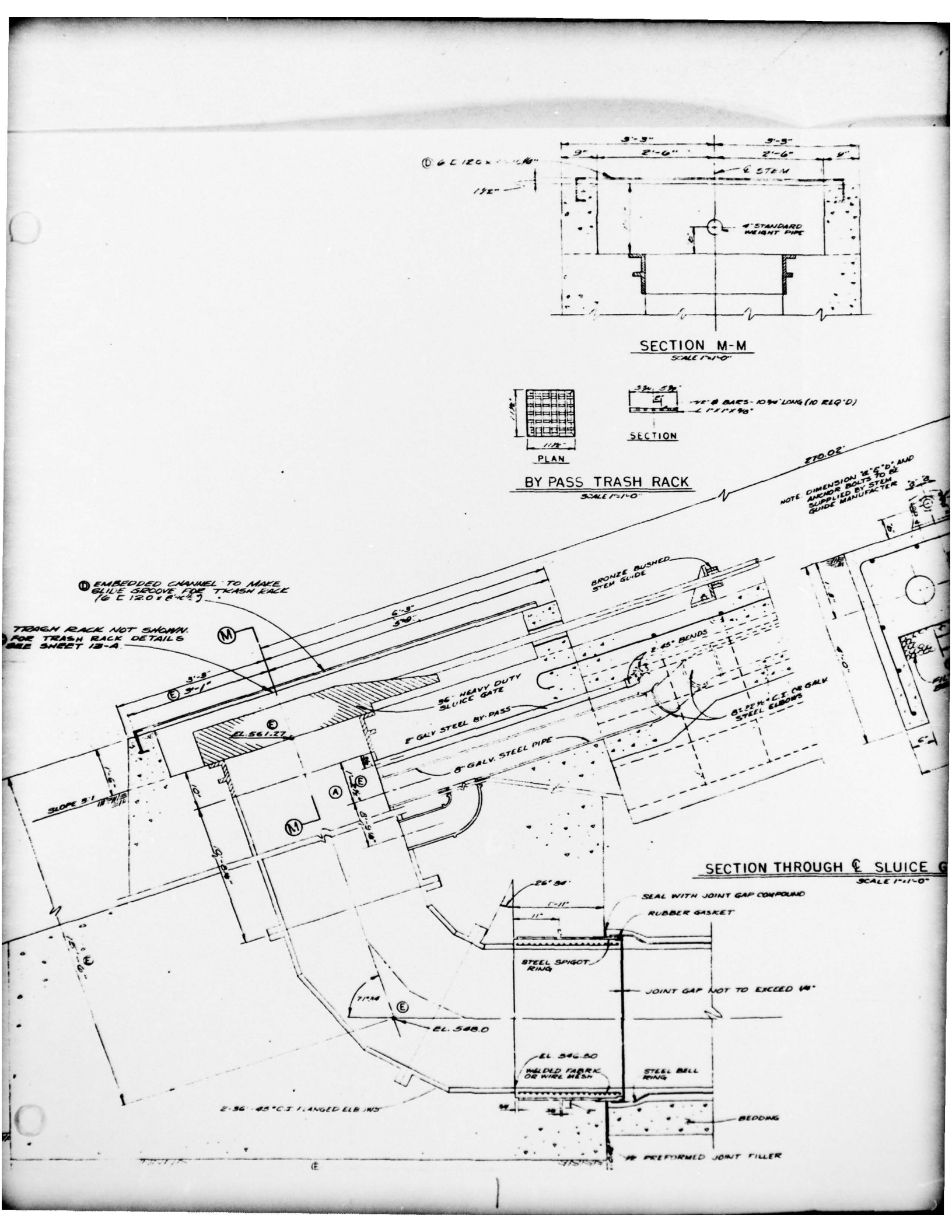


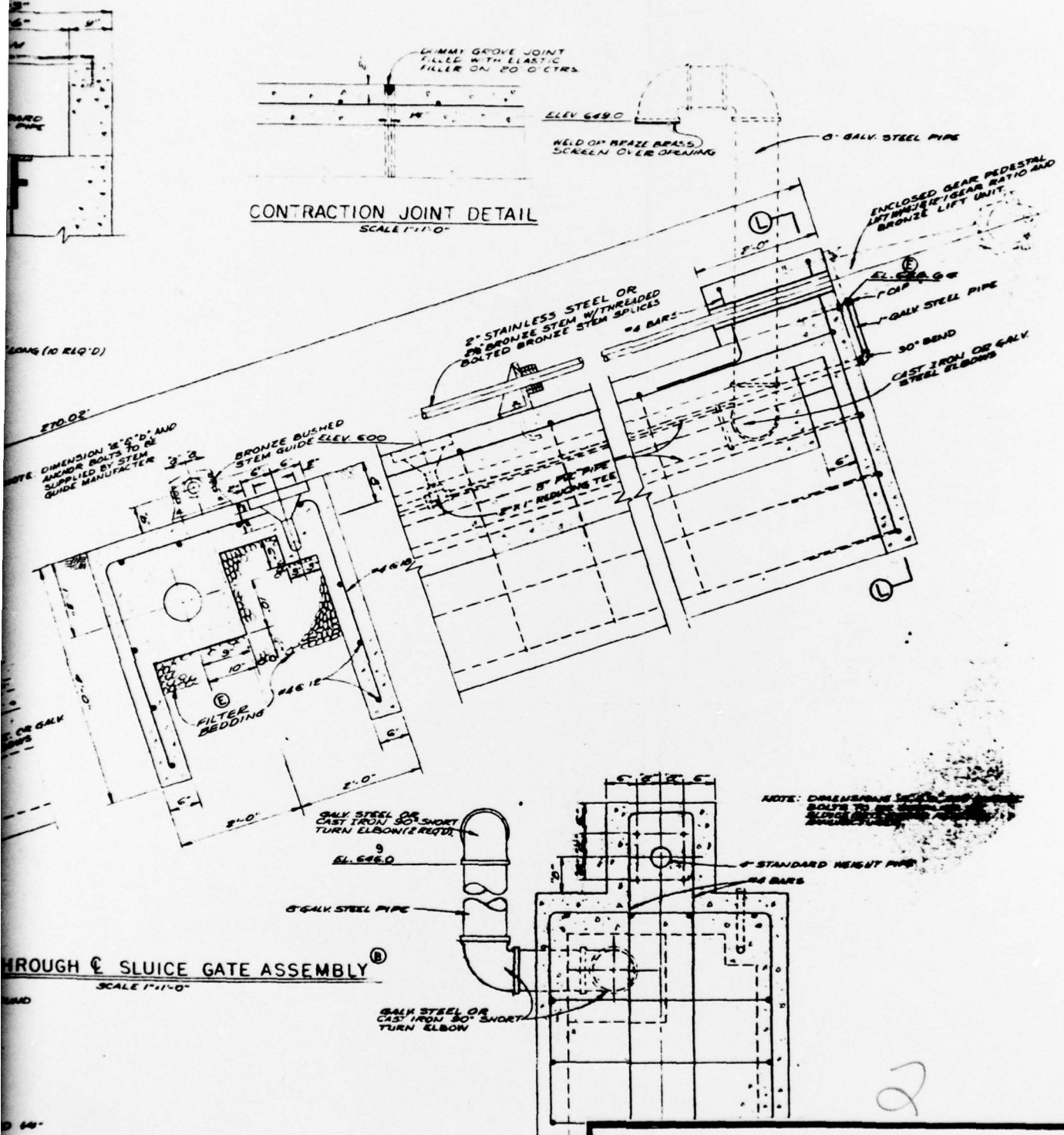
OF SERVICE PIPE

SCALE 1"=40'

2

SECTION OF POND DRAIN LAKE WYNONAH DAM	
NAT.ID NO. PA.00702	SCHUYLKILL COUNTY
DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., MEMPHIS, TENN. DWG. NO. 7970-D-12, SHEET 12 OF 15, DATED SEPT., 1970	
	PLATE 4


SECTION M-M
SCALE 1"=1'-0"
PLAN
SECTION
BY PASS TRASH RACK
SCALE 1"=1'-0"
EMBEDDED CHANNEL TO MAKE GLIDE GROOVE FOR TRASH RACK
TRASH RACK NOT SHOWN. FOR TRASH RACK DETAILS SEE SHEET 13-A
BRONZE BUSHED STEM GLIDE
2-45° BENDS
36" HEAVY DUTY SLUICE GATE
8" GALV STEEL BY-PASS
8" GALV. STEEL PIPE
EL. 561.27
SLOPE 3:1
SECTION THROUGH ℄ SLUICE G
SCALE 1"=1'-0"
SEAL WITH JOINT GAP COMPOUND
RUBBER GASKET
STEEL SPIGOT RING
JOINT GAP NOT TO EXCEED 1/8"
EL. 548.0
EL 546.50
WELDED FABRIC OR WIRE MESH
STEEL BELL RING
BEDDING
PREFORMED JOINT FILLER
2-36" 45° C.I. FLANGED ELBOWS



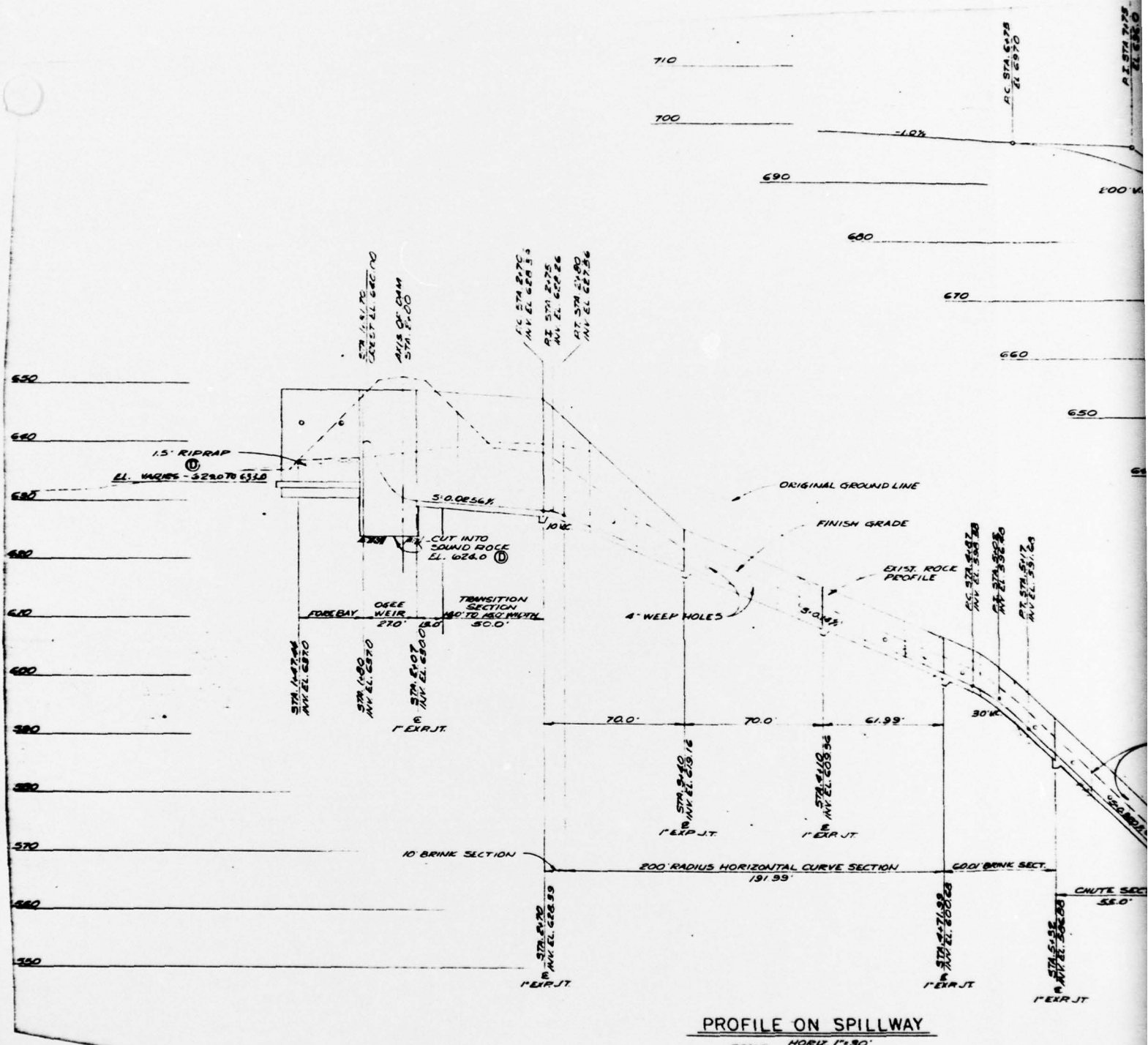
POND DRAIN DETAILS

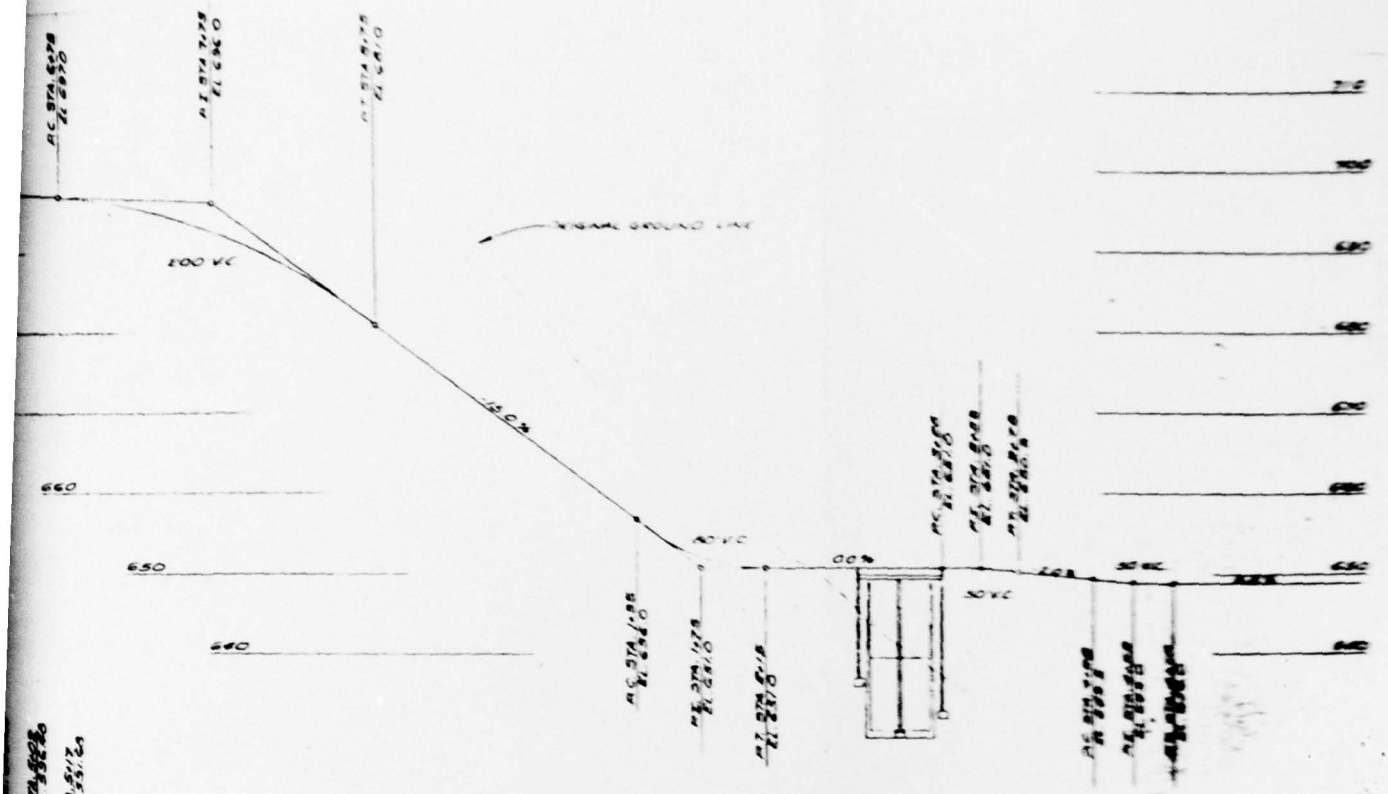
LAKE WYNONAH DAM

NAT. ID NO. PA. 00702 SCHUYLKILL COUNTY

DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., MEMPHIS, TENN. DWG. NO. 7970-D-13, SHEET 13 OF 15, DATED SEPT. 1970

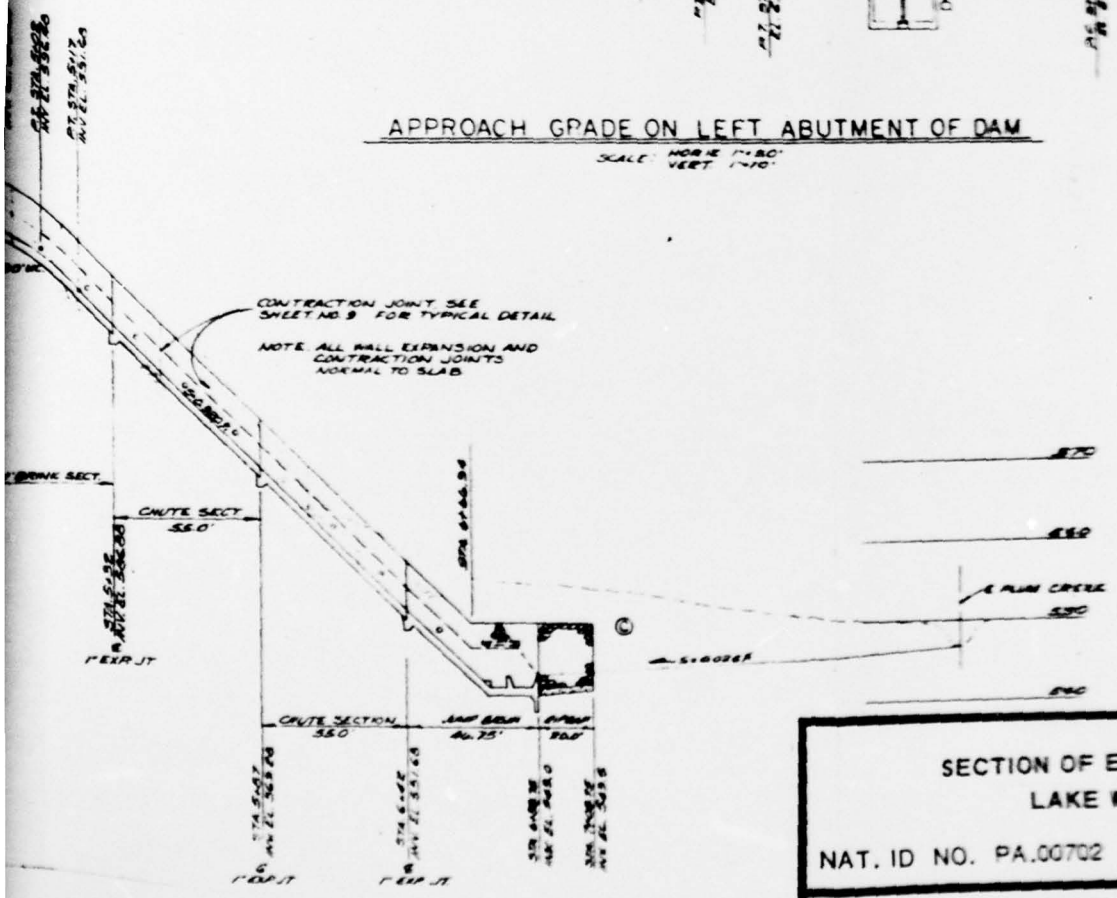
PLATE 5


710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
1.5' RIPRAP
EL. VARIES - 629.0 TO 633.0
5:0.0256%
10'-0"
CUT INTO SOUND ROCK EL. 624.0
ORIGINAL GROUND LINE
FINISH GRADE
EXIST. ROCK PROFILE
4" WEEP HOLES
FOREBAY
OGEE WEIR
27.0'
TRANSITION SECTION 140' TO 160' WIDTH 30.0'
70.0'
70.0'
61.99'
30'-0"
10' BRINK SECTION
200' RADIUS HORIZONTAL CURVE SECTION
191.99'
600' BRINK SECT.
CHUTE SECT. 55.0'
℄ EXP JT.
PROFILE ON SPILLWAY
SCALE HORIZ. 1"=30'
VERT. 1"=10'



APPROACH GRADE ON LEFT ABUTMENT OF DAM

SCALE: HORIZ 1"=80'
VERT 1"=10'

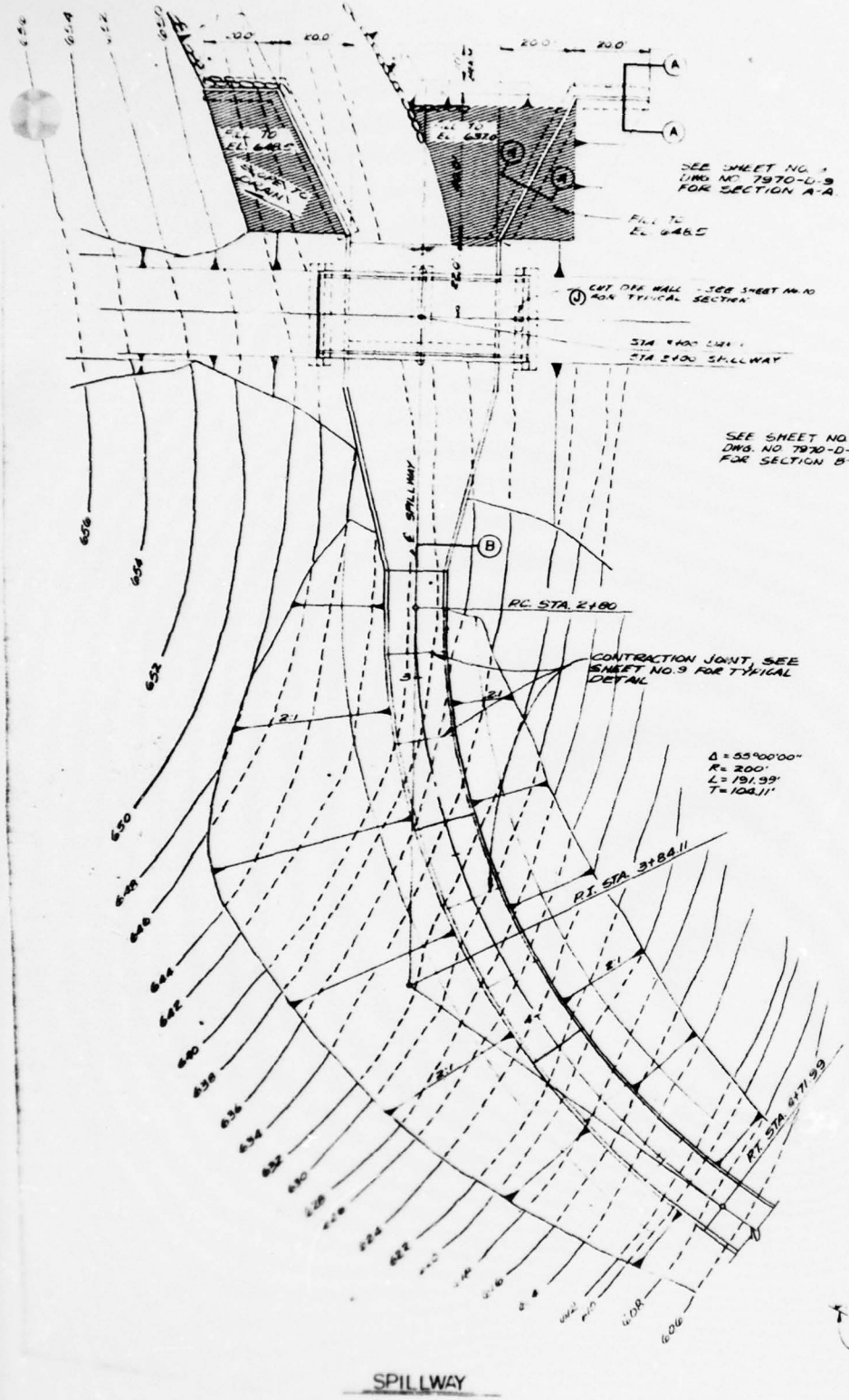


SECTION OF EMERGENCY SPILLWAY
LAKE WYNONAH DAM

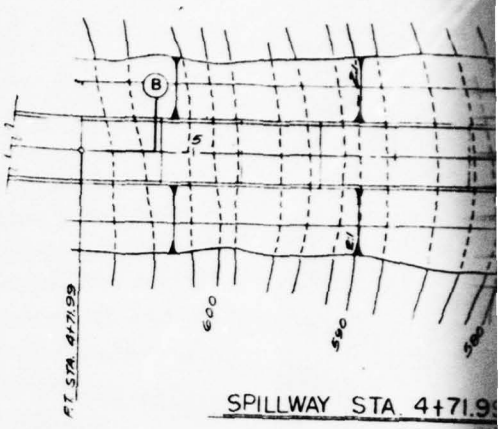
NAT. ID NO. PA.00702 SCHUYLKILL COUNTY

DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., DWG. NO. 7970-D4, SHEET 8 OF 15 DATED SEPT. 1970

PLATE 6

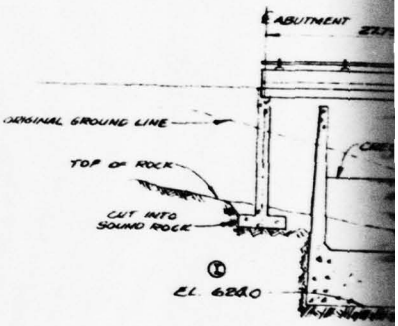


SPILLWAY

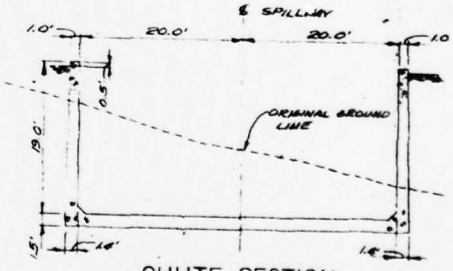


SPILLWAY STA. 4+71.9

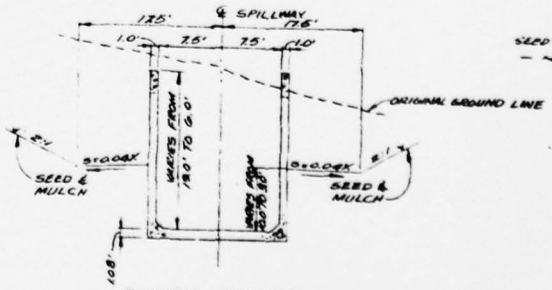
SCALE



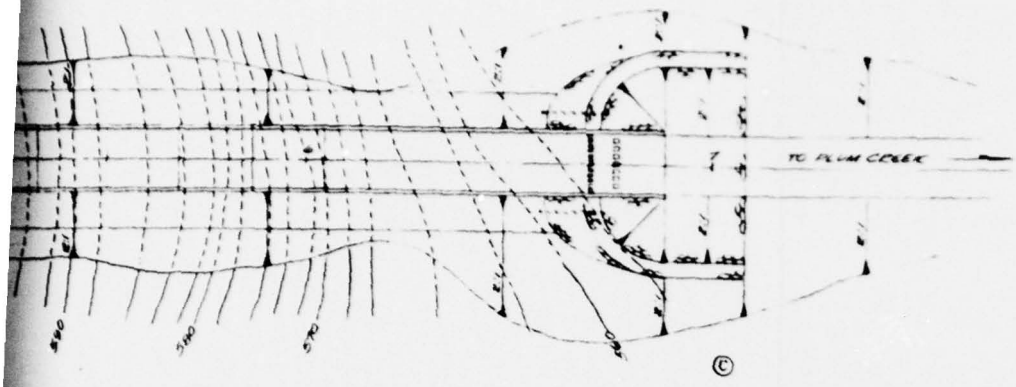
SPILLWAY



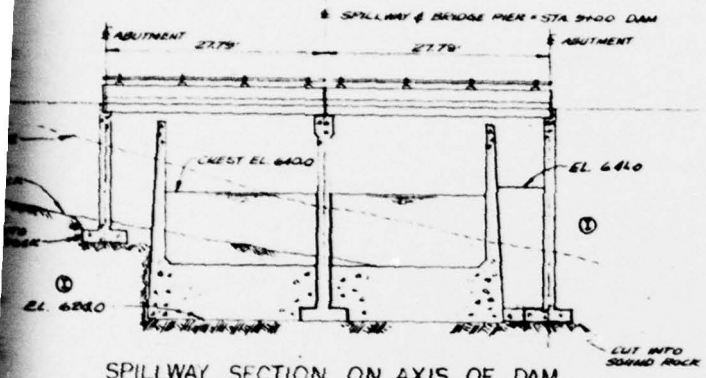
CHUTE SECTION
(STA 2+07 TO STA 2+20)
SCALE 1"=10'



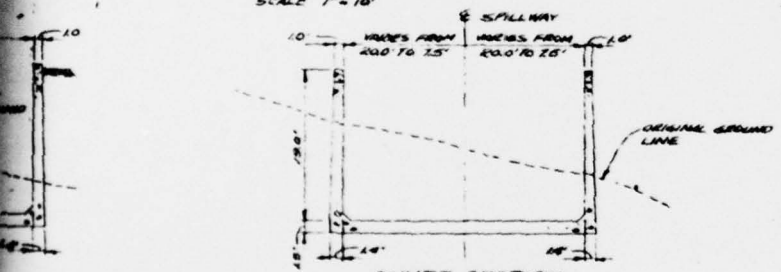
CHUTE SECTION
(STA 2+70 TO STA 3+40)



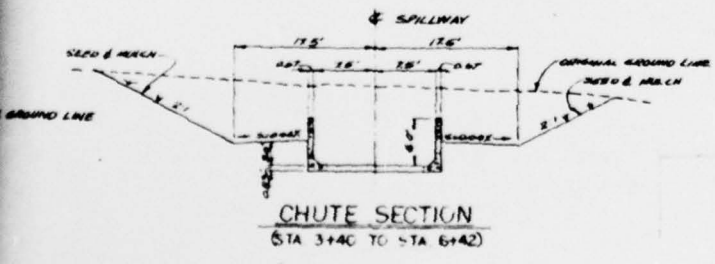
LWAY STA 4+71.99 TO STA 6+62.0
SCALE 1"=20'



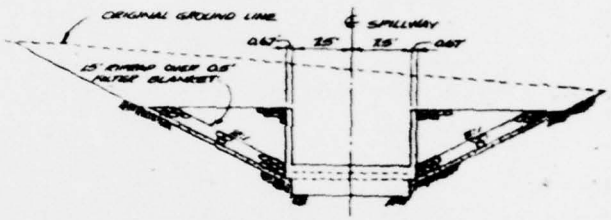
SPILLWAY SECTION ON AXIS OF DAM
SCALE 1"=10'



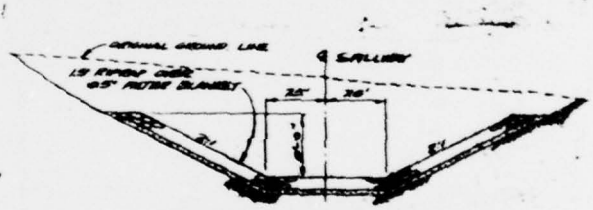
CHUTE SECTION
(STA 2+20 TO STA. 2+70)
SCALE 1"=10'



CHUTE SECTION
(STA 3+40 TO STA 6+42)



CHUTE SECTION
Ⓗ (STA 6+88.75)
SCALE 1"=10'



SPILLWAY OUTFALL CHANNEL
Ⓗ (STA 6+88.75 TO STA. 7+08.75)
SCALE 1"=10'

SPILLWAY OUTFALL CHANNEL

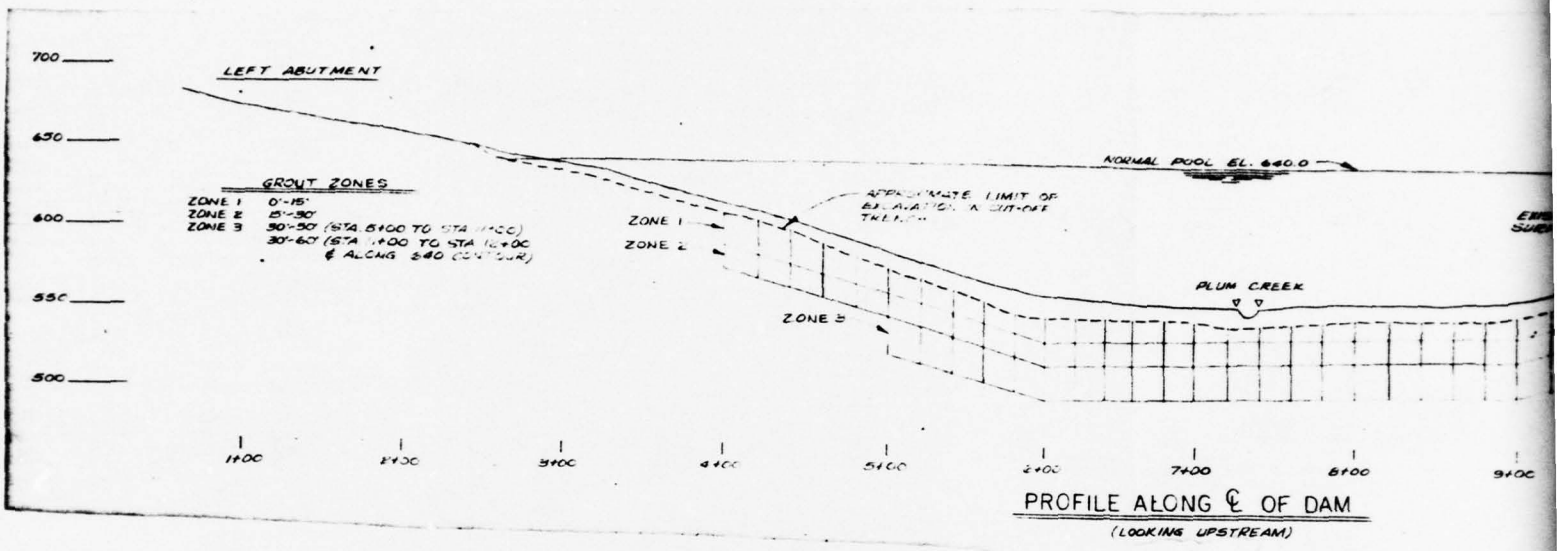
2

EMERGENCY SPILLWAY DETAILS
LAKE WYNONAH DAM

NAT. ID NO. PA.00702 SCHUYLKILL COUNTY

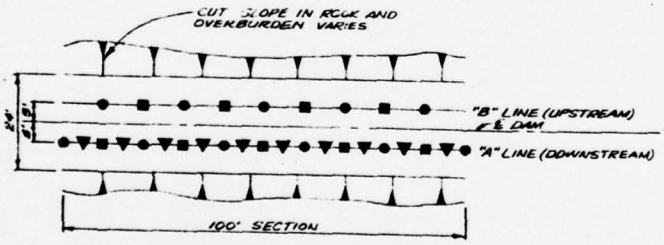
DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., MEMPHIS, TENN. DWG. NO. 7970-D-7, SHEET 7 OF 15, DATED SEPT. 1970

PLATE 7



PROFILE ALONG ℄ OF DAM

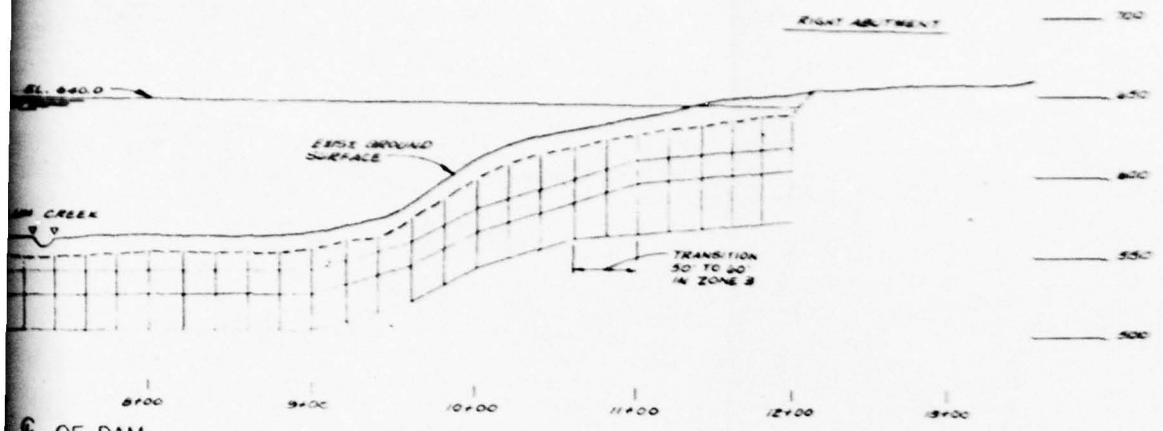
(LOOKING UPSTREAM)

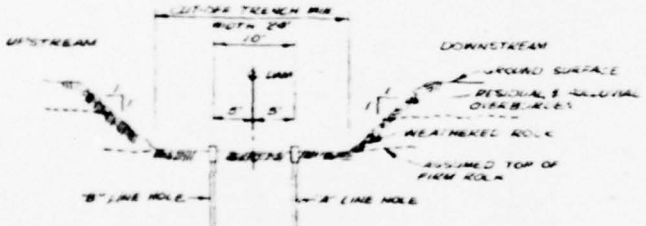


MULTIPLE LINE GROUTING PLAN

LEGEND

- ● PRIMARY GROUT HOLES
- ■ SECONDARY GROUT HOLES
- ▼ TERTIARY GROUT HOLES





TYPICAL SECTION
CUT-OFF TRENCH

2

SUBSURFACE GROUTING DETAILS LAKE WYNONAH DAM		
NAT.ID NO. PA.00702		SCHUYLKILL COUNTY
DATA OBTAINED FROM AMERICAN REALTY SERVICE CORPORATION, ENGINEERING DEPT., MEMPHIS, TENN. DWG. NO. 7970-D-6, SHEET 6 OF 15, DATED SEPT., 1970		
		PLATE 8

TABLE I
GRADATION FOR RIPRAP FILTER BEDDING

U.S. Standard Sieve Size	Percentage by Weight Passing
2"	100
1-1/2"	90 to 100
1"	70 to 90
3/4"	55 to 85
3/8"	15 to 70
No. 8	0 to 60
No. 16	0 to 50
No. 50	0 to 30
No. 100	0 to 15
No. 200	0

TABLE II
GRADATION FOR FILTER BLANKET MATERIALS

U.S. Standard Sieve Size	Percentage by Weight Passing
3"	100
1-1/2"	85 to 100
3/4"	75 to 95
3/8"	65 to 85
No. 8	40 to 70
No. 16	35 to 65
No. 50	15 to 45
No. 100	10 to 35
No. 200	5

APPENDIX

F

SITE GEOLOGY
LAKE WYNONAH DAM

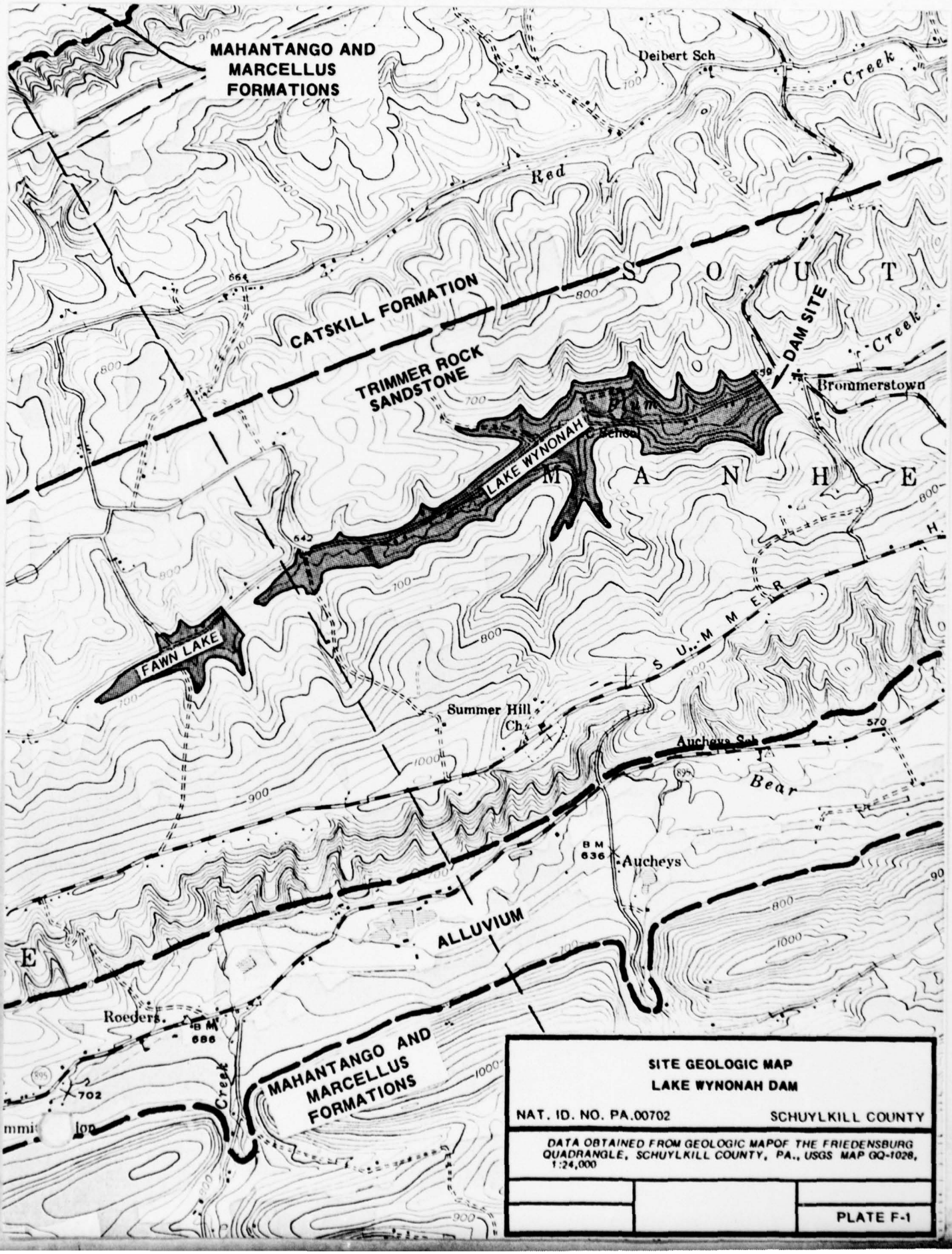
The Lake Wynonah Dam is located at the Appalachian Mountain section of the Valley and Ridge Physiographic Province. The bedrock at the dam site is reported to consist of the sandstones, siltstones, and shales of the Devonian Trimmers Rock and Catskill Formations (see Plate F-1). These units are bounded on the north and south by the Devonian Mahantango and Marcellus Formations. Bedding is reported to be folded into a broad open syncline trending N70°E, with the dam located on the north dipping limb (Wood and Kehn, 1968). Bedding at the dam is reported to dip to the northwest at 45° (Jewell and Associates, 1970). Jointing data was not available for the dam site, but, the primary joint set in this region is usually striking parallel to bedding, while dipping perpendicular to the bedding surface (Wood, 1973). No faults have been reported in the Devonian rocks in this area. The site is in an unglaciated portion of Pennsylvania, with only a relatively thin residual soil reported (Jewell and Associates, 1970).

References:

1. *Jewell, G.K., and Associates, Soils Engineering Consultants, Columbus, Ohio, 1970, Subsurface Investigation, Lake Wynonah, Schuylkill County, Pennsylvania: Report to American Realty Service Corporation, Memphis, Tennessee.*

2. *Wood, G.H., 1973, Geologic Map of the Pottsville Quadrangle, Schuylkill County, Pennsylvania: USGS Map GQ-1028, 1:24,000.*

3. *Wood, G.H., and Kehn, T.M., 1968, Geologic Map of the Swatara Hill Quadrangle, Schuylkill and Berks Counties, Pennsylvania, USGS Map GQ-689, 1:24,000.*



SITE GEOLOGIC MAP
LAKE WYNONAH DAM

NAT. ID. NO. PA.00702 SCHUYLKILL COUNTY

DATA OBTAINED FROM GEOLOGIC MAPOF THE FRIEDENSBURG QUADRANGLE, SCHUYLKILL COUNTY, PA., USGS MAP GQ-1028, 1:24,000

PLATE F-1